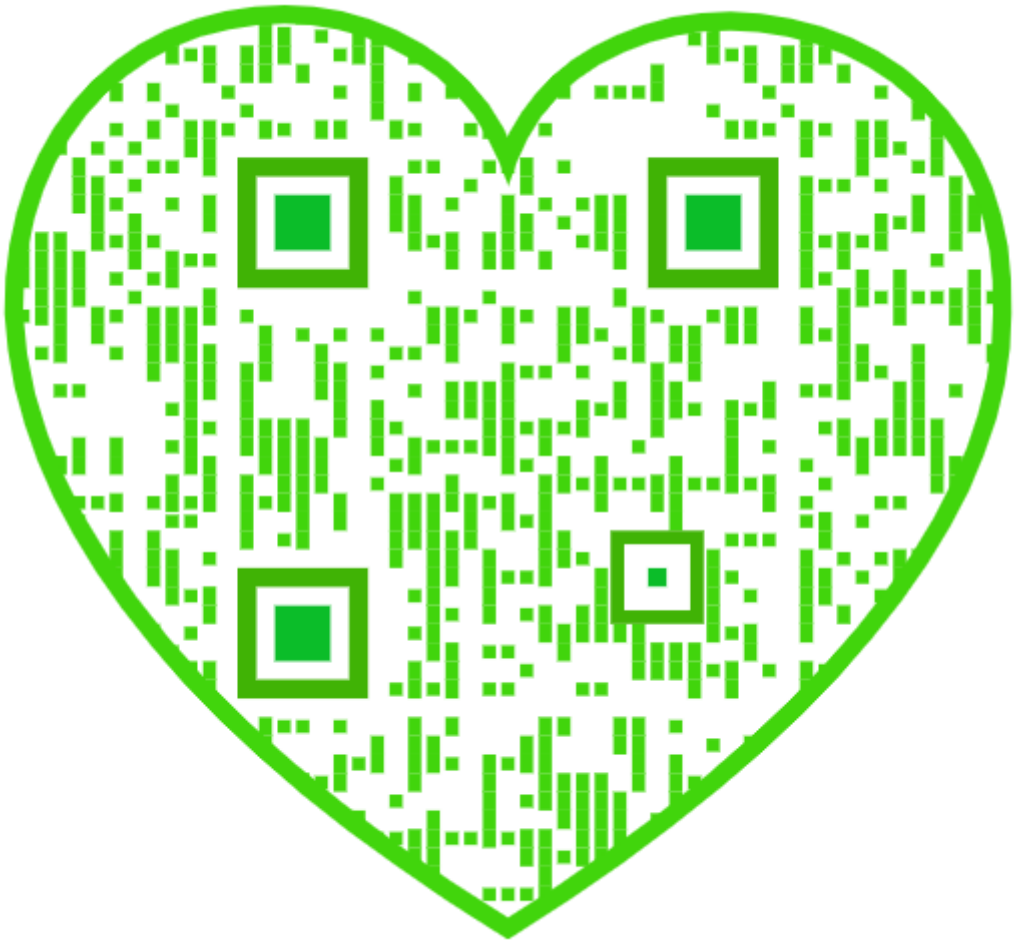

HAND-BOOK

OF

DENTAL ANATOMY AND SURGERY

FOR THE USE OF

STUDENTS AND PRACTITIONERS.

BY

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PREFACE.

DURING the Summer Session of 1856, it was proposed that I should deliver at the Medical School, Surgeons' Hall, a short course of lectures on Dental Surgery. Throughout that and subsequent sessions, I felt the want of a concise work on the subjects brought under notice. Several excellent and comprehensive treatises on the Anatomy and Diseases of the Teeth no doubt existed; but they were not of a character suiting the requirements of the class. Along with advanced medical students, a considerable number of the pupils were the ordinary assistants of dental practitioners, and unacquainted with many of the mere elementary facts in medicine. The idea thus occurred to me of

drawing up a volume of small size, and of such a nature as would render it acceptable to medical students, while it would afford to non-medical pupils an epitome of those leading facts in anatomy and physiology, essential for entering on the study of dental disease.

The conviction that an exclusively special knowledge of any one department of medicine or surgery was objectionable, almost led me to treat the subject in a manner pre-supposing some advance to have been made in the usual branches of a medical education. This, however, would have frustrated the end I had in view. I have therefore attempted nothing more than an exposition, in a condensed form, and simple terms, of the anatomy and pathology of the teeth in relation to ordinary dental practice.

In a work of the kind there can be little claim to originality, beyond the selection and arrangement of proper materials, and their reduction to the smallest space consistent with perspicuity.

In doing so, I have availed myself of the advantages afforded in the works of such authorities as Owen, Goodsir, Tomes, &c., and made whatever selections seemed suitable for the purpose from some of my own published papers.

The small size of the volume necessarily renders the treatment of many subjects terse. But it will be found that very few, if any, of practical interest have not been touched upon; while those of more general utility have been discussed at considerable length.

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November 1864.

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DENTAL ANATOMY AND SURGERY.

CHAPTER I.

INTRODUCTORY.

THE PRINCIPAL FORMS OF TEETH IN THE LOWER ANIMALS.

MUCH importance has always been attached to Anatomy and Physiology as a means of elucidating not only the nature but the diseases of a part. In general, however, the anatomy merely of the part itself cannot be deemed sufficient for such purposes: its dependence on, or its associations with, others cannot be set aside. Because in many cases the diseased no less than the healthy condition of one, depends upon the functional condition of some other organ, so remote, perhaps, as never to be suspected, without a previous acquaintance with the connection subsisting between them. Proceeding upon the same principle, and going a step further, it

is of much advantage in many ways, that, besides the Human anatomy of any organ or set of organs, we should be aware of those peculiarities which may attach to the Comparative anatomy of similar parts. Many things become far more comprehensible in human anatomy when we refer to the same structure—existing, perhaps, in a higher state of development—in some of the lower animals; as, for example, in the case of the canine teeth in man, where we find them but feeble representatives of those organs in their more perfect state among the carnivora.

In this manner a knowledge of anatomy and physiology, in their fullest sense, and in their combined application to pathology, or the laws of disease, becomes the basis of all scientific medicine. Every irregularity, every defect in form, every morbid symptom, may be judged of on such a basis. Whether the nature of a mere localised disorder be inquired into, or the cause of disease in one part be sought for as associated with some altered function in another, physiology affords the key to its interpretation: anatomy, the standard by which to estimate the organic change incurred.

What has here, however, more particularly to be considered, is of local limits, and must be restricted to the anatomy and pathology of the dental system alone. The method followed must therefore partake to a considerable extent of what is termed the *déduction anatomique* of the French physiologists, namely, the examination of the component textures and external forms of one system of organs specially, and, by inference, the deduction of their functions and their conditions in health and disease.

COMPARATIVE ANATOMY.

In entering upon the study of dental disease, it is, then, expedient that a correct general knowledge should be possessed regarding the various forms assumed by teeth. This subject presents a twofold aspect, as has been already adverted to—naturally dividing itself into two separate although associated branches—the one as applied more particularly to the pathology of these organs in man; the other relating to the teeth of the lower animals, and extending its application more particularly to the department of natural science. Before proceeding, then, to describe the dental system of man, a few of the

principal forms of teeth in the lower animals may be briefly mentioned.

The teeth of the human subject afford but a very limited and imperfect idea of these organs throughout the animal kingdom. Among the lower animals, the number, the form, the situation, and the uses of teeth, vary to a very great degree. In Number we have them varying from the countless teeth of some fishes, to the solitary tooth of the monodon or narwhal—the tooth so well known for its resemblance to the unicorn's horn of heraldic notoriety. In Position, we have them not confined to the jaws, as in man, but, as in fishes and reptiles, scattered over all the bones of the mouth, the tongue, the gullet, and, if we include some still lower animals, such as crabs, beetles, and various insects, we find teeth, or organs corresponding to them, situated even in the stomach. In Form, again, we have them infinitely diversified. From simple flat plates, as in some of the ray and skate group of fishes, we have them modified, till we find them assuming the form of the elephant's tusk, or the whalebone of the cetacean family, producing that peculiar substance. In their Uses we find them serving the purposes of attack in the lion;

of building in the beaver; of climbing and progression in the walrus; of digging in the extinct dinotherium; of prehension in fishes; of poisoning in serpents; and of speech and appearance in man.

Nothing like a common pattern or type of teeth, either in form or position, prevails among animals lower in the scale of being than the fishes. It is only when we rise to them,—belonging as they do to the vertebrate or backboned animals,—that these organs can properly be recognised as a system.

In some of the rotiferæ or wheel animalcules, we have a teeth-like apparatus in the stomach. Among these minute animals the *Brachionus urceolaris* presents an apparatus of this kind, consisting of two little hammer-like teeth, working upon another tooth or dental body, the whole acting like two hammers striking on one anvil, and in this way reducing the food to a proper consistence for subsequent digestion.

In the echinus or sea urchin, again, an animal well known on our sea coasts, a somewhat complex form of jaws and teeth exists. Five bent and pointed teeth project from that part of the shell forming the mouth; each of these five

teeth is contained in a separate jaw, which is movable; and their mode of use is peculiar, inasmuch as, while the food is seized by the teeth, it is ground down by the adjacent sides of the jaws themselves rubbing against each other.

Many insects have a system of horny teeth situated in the stomach or gizzard.

The common crab has not only a dental apparatus external to the body, but is provided with a powerful form of teeth within the stomach.

The ordinary limpet of our shores has its long tongue thickly bristling with regularly arranged teeth in immense numbers.

The peculiar wound inflicted by the leech is familiar to every one. Its triangular bite is produced by the action of three little semicircular saws, which constitute its dental apparatus.

Even the common snail has a peculiarly constructed set of teeth, resembling a small comb; and with this it can rapidly cut down the vegetable matter among which it feeds.

No more, however, need be said of the diversified forms of teeth met with in animals lower than the fishes. Passing on to them, therefore, we leave the invertebrate and enter the verte-

brate division of animals. The teeth of the vertebrata—fishes, reptiles, and mammals—are all, more or less, of the same characters; they are all modifications of a cone in their form, and they are always situated in, and in the neighbourhood of, the mouth. In such respects, however, they present considerable variety among themselves.

The simplest forms of these teeth are such as are met with in some fishes. In the skate and several allied individuals, the teeth consist of flat plates of bone, covering the interior of the mouth like a pavement. The first approach towards a conical or pointed form of tooth may frequently be found occurring in such a pavement, by some of its flat plates becoming prominent at the centre, and indicating a tendency to assume the projecting or cone-shaped form described. Passing to other fishes, we find cone-shaped teeth to have become the general rule, until they present the high degree of development seen in such examples as the pike, the sea-wolf, and some sharks—the pike with its array of strong, recurved, pointed blades, calculated for retaining its slippery prey; the sea-wolf with its prehensile and powerful grappling teeth,

situated in the front of its mouth, and its no less powerful crushing ones behind; and the sharks, with their remarkable dental system, composed of tier upon tier, all round the jaws, of flat triangular teeth, compressed cones, in fact, an arrangement perfectly adapted to the savage nature and voracious habits of these creatures.

The next class of animals higher than the fishes is that of the reptiles, and among them we find some remarkable forms of teeth, constituting still, however, only further developments of the cone. This class of animals is more properly divided into two, namely, Batrachia and Reptilia; here, however, both are included under the name of reptiles.

Some of these animals, such as turtles and tortoises, have no teeth, but merely a horny covering extended over the jaws; others, like frogs, have only upper teeth; while others, again, such as some serpents, have teeth not only in both jaws, but also situated upon the palate. Among the various examples of reptilian teeth, crocodiles and serpents present some points of greater interest in their dental apparatus. The number of teeth in the crocodile seems to re-

main the same throughout the long life of this animal, but they individually increase in size as the animal grows, and go on being shed and renewed as long as it lives. In the poisonous serpents, again, there is found a characteristic form of tooth, viz., the poison fang, sometimes erroneously spoken of as the sting. This weapon consists of a long, curved, and pointed tooth, situated on each side near the fore part of the mouth. This tooth is hollow or tubular throughout its length, the tube commencing at its root and ending near but not quite at its point, in a small hole opening on the surface of the tooth. The object of this construction is, that on the animal using this tooth, the poison contained in the poison-bag connected with its root is injected along the tooth into the wound thus made. These teeth, except when the creature is irritated and about to use them, lie flat upon the surface of the mouth, being provided with a hinge-like articulating apparatus for this purpose.

Among extinct reptiles many interesting forms of teeth exist, and, according to their dental peculiarities, several of these animals have been named. The Dicynodon appears to have been a kind of tortoise, with two large and ever-grow-

ing tusks situated in its upper jaw, and curving downwards and forwards. The Labyrinthodon, as its name implies, was provided with pointed teeth of a very complex structure, their tissues being arranged in a number of inflections inwards from the surface. This animal was a gigantic lizard-like toad, but not of such enormous proportions as the Iguanodon, another elephantoid reptile, named from its teeth presenting a character similar to those of the iguana, their shape being of a peculiar palmate or leaf-like form, with sharp serrated edges, adapted for cutting down the vegetable matters upon which the iguanodon subsisted. And among animal-feeders we find the Megalosaurus, another stupendous lizard, some thirty feet long, and furnished with an apparatus of teeth in the form of long, curved, double-edged blades, not only cutting at these edges, but having them provided with serrations, which enabled these formidable creatures literally to saw through the tough hides of their usual victims.

In the mammalia the teeth are confined to the upper and lower jaw, and in most instances are renewed once during a lifetime. In some animals no renewal or second series of teeth is

provided; so that in their case the teeth are never shed and succeeded by others, as occurs where a temporary and a permanent set exist; but on any tooth being lost by them, it is never replaced. The dolphins, the armadillos, and the sloths, are examples of this form of dentition.

Another peculiarity exhibited by some teeth among the mammalia is that of continuous and uninterrupted growth. This is seen in the incisors of rodent animals, in the molars of the sloth, in the tusks of elephants, and some other similar kinds of teeth. The object of such a mode of development is, that as the tooth is being worn down at its point, it continues constantly growing at its base, thus maintaining its normal bulk and usefulness; and so persistent and certain is the occurrence of this growth, that in cases where the usual abrasion of the extremity of the tooth becomes arrested, it goes on increasing in length until it constitutes not only an inconvenience, but sometimes a cause of death, in the animal to which it belongs, by impeding the motion of the jaws, and thus leading to starvation.

The teeth in the mammalia may, in a general manner, be classified into those of the carnivora,

those of the herbivora, and those partaking more or less of the characters of both, as in the omnivorous animals, such as man.

Of the carnivorous order, the lion may be selected as illustrating all those characters of a dental system perfectly adapted for a terrestrial flesh-feeding animal. The jaws are here found massive and short, so that the teeth are situated as near the articulation as possible—that part, in such a form of lever as the jaw, where the power is greatest. And we find the teeth themselves equally well suited for their work. We find the canines long, powerful, and securely implanted in the jaw, in every way adapted for deeply wounding and retaining a living and struggling victim. The molar teeth, again, instead of presenting a broad, tuberculated, crushing surface, as in man, present something like a wavy knife edge, and closing over one another when the upper and lower jaws meet, they divide the substances submitted to their action, as the blades of a pair of scissors are found to do. They are, in short, sectorial instead of grinding teeth. The incisors, again, are short, nibbling organs, intended, and well adapted, for gnawing the fragments of soft tissues left adhering to the bones

after the more arduous duties have been fulfilled by the canines and molars.

The ruminant animals, such as the ox, may be taken as affording a well-marked example of the herbivorous form of dental system. In the these animals we find the canines absent, or but in a rudimentary condition; we find the incisors frequently deficient in number, and adapted for the browsing propensities of the owner; while the molars are provided with sharp ridges of enamel interspersed throughout their substance, so that the free or grinding surface of the tooth presents an alternation of hollows and sharp ridges, well calculated for bruising and reducing to a pulp the vegetable matters serving these animals as food, but which would be utterly ineffective for the purposes of such creatures as the lion. The jaw, too, in the herbivorous animal is long and slender, and at its extremity, where the canines are occasionally slightly represented, its action is comparatively feeble and unsteady.

Among the mammalia another form of teeth is worthy of notice here, namely, those belonging to that form of whale producing "whalebone," and which constitute that particular sub-

stance. Along the sides of the palate in these animals the upper teeth are arranged in the form of horny plates, depending downwards into the mouth, their lower extremity terminating in a sort of hair-like fringe. These teeth constitute the whalebone of commerce, and the use of such a construction of teeth is that, on the whale admitting within its widely-opened jaws a shoal of the small animals serving it for food, its mouth is again closed, and the water being strained off through the horny fringes of the baleen plates, its prey is thus retained and swallowed.

When speaking of the teeth of reptiles, several of the extinct forms of these animals were alluded to. Among the mammalia there are also found several interesting forms of teeth belonging to animals now extinct. The Dinotherium, the Mastodon, and the Mammoth, may be mentioned as illustrative examples. These were all enormous animals possessed of tusks resembling those of the existing elephants. The dinotherium had a pair of such tusks curving downwards from its lower jaw. The mastodon, in addition to a pair of tusks in the upper jaw, as elephants have, had also a pair situated in the

lower jaw. And the mammoth was provided with a pair of tusks in the upper jaw, some of which have been found nearly 12 feet long, and weighing 200 lbs. Besides such tusks, these animals were provided with molars of proportionate magnitude, some specimens of those in the mastodon weighing from 17 lbs. to 20 lbs. each.

Such are a few examples of teeth as they occur in the lower animals, some circumstances connected with which subject will be found to bear upon certain apparent anomalies in the pathology of the human teeth.

CHAPTER II.

GENERAL CHARACTERS OF THE TEETH IN MAN.

ANATOMISTS consider 44 instead of 32 to be the typical or model number of teeth belonging to those animals comprising the mammalia, and therefore they consider that certain teeth in man, and in several other animals, are suppressed; 44 ought, as it were, to be present, but 12 of those in man are suppressed, reducing the number to 32. A knowledge of this diminution in the typical number of teeth in man is so far interesting, as it affords one explanation of the occurrence of what is sometimes believed to be a third dentition,—the growth of a third series of teeth; as well as the occasional existence of extra teeth in the mouth. Such supernumerary members, in both cases, frequently indicate merely the tendency towards a return to the original or typical number, which had been in the first instance departed from.

These 32 teeth are arranged and classified in the same way, in both the upper and lower jaw, —16 in each. In front, above and below, are 4 cutting teeth, flat at their edges, and termed Incisors. Bounding these, on each side, is a conical spear-shaped tooth, termed the Canine or eye-tooth. Behind the canine we have 2 small tuberculated teeth, termed Bicuspids, or small grinders,—2 on each side, above and below. Behind these again we have 3 large grinders, or the true Molar teeth—3 on each side, above and below. These 3 true molar teeth only appear once in a lifetime, and only with the permanent teeth. They are not represented at all in the temporary set, or milk-teeth of the child; so that the first or milk-set differs from the second or permanent set, in being 12 teeth fewer,—6 above, and 6 below. The milk-set thus being only 20 in number, instead of 32, and the difference consisting in the absence of any direct predecessors to the true molar teeth.

Man differs from all other animals in the arrangement of his teeth. In him, they are all of one length, all on the same level at the crowns. Again, no interspaces exist among them, every tooth being close to the one next it;

whereas, among the lower animals, empty spaces exist at certain parts along the jaw, the series of teeth being interrupted by gaps or vacancies, generally occurring near the canine teeth; and, in such animals, these canine or eye teeth themselves are almost always much longer than any of their neighbours, and thus over-top them considerably. The existence of these unoccupied spaces, these gaps among the teeth of the lower animals, may very well account for their not suffering, as man does, from irregularity or crowding of the teeth; and probably the extra room thus afforded may explain also why animals suffer so much less during dentition or teething than is the case in man, where the jaw is barely, if it is actually sufficient, to contain the teeth with which it is normally furnished.

Again, in reference to these more external characters of teeth, each is coated or capped, on its exposed portion or crown, with a dense hard covering of what is termed enamel; and, on its root or fang, or that part imbedded in the jaw, it is coated with another and softer substance, termed cement. In this way each tooth is composed of three different substances, to be presently described, viz. :—1*st*, a body or base, com-

posed of dentine; 2*d*, a cap, investing the crown, and termed enamel; 3*d*, a substance coating that, and termed cement.

Lastly, so far as external form is concerned, the character of root or fang, exhibited by each tooth, is one of the chief marks by which these organs are distinguished from each other. The natural form of root, as is more fully described in another chapter—viz., that on the anatomy of these parts—is in all the incisor teeth, above and below, a single, straight, conical fang. In the canine teeth the same form is observed. In the bicuspids of the lower jaw, the same style of root continues, but in those of the upper jaw the root inclines to be double,—to divide into two fangs. In all the upper molars, the number of fangs is three; two outside, and one towards the palate. In all the lower molars the natural number of the fangs is two, one behind the other.

A knowledge of the character of root and fang possessed by each tooth is one of the chief guides we possess for distinguishing these organs from each other; and a knowledge of the number, form, and direction of these fangs is essential for the skilful performance of tooth extrac-

tion,—as by such acquaintance a tooth is extracted with much more rapidity, and greater ease both to operator and patient, than by a blind attempt at removal without attention to its form and mode of fixation.

Besides a familiarity with the form of these organs, a knowledge of their intimate structure and mode of development is necessary for correctly understanding their diseases.

At an extremely early period of life—at the mere dawn of existence, indeed—there is formed, in the mucous membrane of the mouth, occupying the situation of the future teeth, a groove or trench, extending in a horse-shoe shaped, or rather crescentic form, round the margin of the jaws. This trench is termed the Dental Groove, and within it occur all those processes which constitute dentition or teething; in other words, the growth and development of the teeth.

This process commences at each of those spots along the bottom of the dental groove where a tooth is afterwards to be situated, by a number of very minute blood-vessels becoming congregated together. Very soon these patches of blood-vessels begin to be elevated into little button-like nodules or protuberances; while

between them septa or partitions begin to be developed across the groove, thus providing each tooth-germ with a separate apartment—as yet, however, roofless. In this condition the tooth-germ is termed a papilla, and its containing cavity a follicle. But matters speedily become changed: the tooth-germ rapidly increases in size, and the containing cavity becomes roofed in, and now the roofed in papilla henceforth assumes the designation of the pulp, and the enclosing cavity the name of the sac. This sac is so wide that a space exists between it and its enclosed pulp; but the space thus present is not empty, but is occupied by what appears as a thick transparent fluid, so that three different elements thus enter into the germinal or embryonic condition of the tooth, viz., the Pulp, the Thick fluid surrounding it, and the Sac enclosing both,—the sac and its contents being again lodged in the substance of the jaw.

And now commence those changes by which these as yet soft tissues are converted into the future tooth. The pulp takes on an action by which its soft substance is transformed into the hard material forming the body of the tooth—the material mentioned as being denominated

Dentine. The thick fluid interposed between the pulp and the sac is replaced by the cap of Enamel, described as covering the crown or exposed portion of the tooth; and at a later stage, because the root or fang does not grow until the crown is completed, the sac itself enters into the formation of the substance referred to as coating the root of the tooth, and termed the Cement.

As soon as the crown of the tooth is completed, and long before the root is perfect, the process takes place by which the tooth is "cut," as it is called. This takes place, not by the tooth forcing or tearing a way or passage for itself through the gum and other tissues, but by these tissues themselves making a way for the tooth's escape. An opening is, if we may so speak, *spontaneously* formed in the top of the sac; the tooth protrudes through this opening, and the sides of the sac contracting to a certain extent, the tooth is hoisted by them a little way out of the gum. This lifting up of the young tooth, on its first penetrating the gum, causes it, says Mr Tomes, to appear to grow more rapidly than it really does. Such apparent rapidity of growth during the first few hours of a tooth's existence

in the mouth being, however, deceptive, and arising from the fact just specified.

This constitutes the explanation—the *rationalé* of that strictly natural and healthy process going on in infant life, and termed "teething;" not a step in which is detrimental or to be regarded as disease. Dentition may, like every other natural process, assume a diseased or morbid condition, but in no ordinary case does it deserve the bad character generally assigned it.

The first or temporary set, however, is soon lost and replaced by others which are to be renewed no more—the permanent or adult teeth. The various steps by which this second dentition is effected might here be described; but with some obvious and slight modifications, they so closely resemble those exhibited in the first dentition, that it might be tedious to do more than merely mention this occurrence. What is chiefly to be borne in mind respecting this renewal of the teeth is, that in man and all the higher animals, it occurs in a whole lifetime only once. The general features of the process are the same as those of the first dentition; the follicular and saccular stages occur as in it; enamel, dentine, and cement are formed as in it,

the main differences being that the majority of the teeth in the second or permanent set have had predecessors among those of the first set; they form, as it were, a second crop, and this second crop is much longer in coming to perfection than the first was; inasmuch as within three years after birth all the first crop had appeared above ground, whereas the second is not all up for close upon twenty years more, during nearly all which time one or other of its members has been in process of growth.

The time at which the various teeth of the first and second dentition are "cut," as it is termed, varies considerably. The earliest teeth to appear above the gum in the first or temporary set are the lower central incisors. This takes place about the seventh or eighth month of infant life. In a week or two those of the upper jaw succeed them. The lateral incisors of the upper jaw next appear about the eighth or ninth month, and those of the lower jaw quickly follow. The anterior lower molars are cut from the twelfth to the sixteenth month, and immediately after them come the corresponding teeth in the upper jaw. During the seventeenth or eighteenth month the canines appear, generally

those in the upper jaw first, and before the age of two and a half years the second milk molars generally commence to make their appearance, thus completing the temporary set of teeth.

The second set generally begins to appear about the age of seven years, by the first permanent molars being then cut. These are followed by the permanent central incisors at eight, the lateral incisors at nine, the first bicuspids at ten, the second at eleven, the canines at twelve, the second molars at thirteen, and the third molars at about twenty or twenty-one years of age.

The structure of the three substances mentioned as entering into the formation of a tooth is peculiar, and all of them different from each other.

Dentine, or the body of the tooth, is composed of an infinite number of excessively minute tubes, the walls of which consist of something like bone. These tubes are arranged so as to lie with one end opening at the centre of the tooth, the other terminating at its external surface. Each of these tubes measures in the diameter of its bore about $\frac{1}{10,000}$th of an inch. The use of them seems to be in maintaining the vitality of the

tooth, by drawing nourishment from the vessels running along the central cavity found in each tooth; and perhaps the fibre or small cord-like body described by Mr Tomes as occupying each of the small tubes may also serve to endow the dentine with a certain amount of sensitiveness.

Enamel consists of a collection of minute, dense, and excessively hard columns, closely packed together, and standing upon the surface of the dentine, where that substance is exposed within the mouth, and for which they constitute merely a mechanically protective covering. The general bearing of the enamel columns is at right angles to that portion of the surface upon which they are placed; so that those on the apex of a tooth stand vertically, while those applied to its sides lie horizontally.

Cement is a substance closely resembling ordinary true bone, and acts in the double capacity of assisting the central cavity of the tooth in affording nourishment to the dentine, and as a bond of union between the root of the tooth and its socket. The cement is more largely furnished with the means of deriving a supply of nourishment from the adjoining blood-vessels than the dentine; and as the centre of

the tooth and the surface of its fang are thus provided with the means of sustenance, its vital powers are sufficiently, although feebly maintained.

Whenever any of these three substances are defective or weaker than usual, they are, owing to the small amount of life at best possessed by them, more prone to disease and destruction. In their healthy condition, nature has provided well against the trying circumstances these organs are necessarily exposed to in such a locality as the mouth, not to speak of the heavy work they are sometimes doomed to undergo. But if disease, or even only delicate health, does overtake a tooth, the combined effect of this, and all the evils to which it becomes exposed, speedily result in death and subsequent decomposition or decay of its substance, constituting what is termed "dental caries." The substance of the tooth is in this way destroyed, broken down, and removed; the central canal largely supplied with nerves as well as blood-vessels, and the cement substance, also largely endowed with sensation, either or both become encroached upon; acute pain is the result, and toothache in its true form is produced.

CHAPTER III.

GENERAL ANATOMY OF THE MAXILLARY APPARATUS.

THE anatomy of the dental system cannot be well described or thoroughly understood without taking into account the anatomy of all those structures which, besides the teeth, are involved in the performance of mastication. These structures include the Bones entering into the formation of the upper and lower jaw, the Muscles moving the lower jaw, the Nerves and Blood-vessels supplying these parts, and the Integument covering them inside the mouth.

UPPER AND LOWER MAXILLARY BONES AND TEETH.

What is termed the upper jaw is formed by the junction of two separate bones, one for each side, and termed the right and left Superior Maxillæ or maxillary bones. Each of these bones contains eight teeth in the adult subject, namely, one central incisor, one lateral inci-

sor, one canine, two bicuspids, and three molars. These two bones articulate with each other in the middle line of the face, and from their large extent assist in the formation of the orbit, the nose, the cheeks, and the palate. The superior maxillary bone is very irregular in shape. It may be described as possessing an external surface—that upon which the cheek rests; an internal surface—that applied to the corresponding surface of the bone of the opposite side; and a posterior surface, forming the tuberosity which rounds off the bone behind. Above it presents a smooth flat surface, which forms part of the floor of the orbit. Below it presents an arched surface, entering into the formation of the palate, and having the upper teeth projecting downwards from its external border. Partly enclosed by all these surfaces a large hollow space exists in the body of the bone, termed the maxillary antrum, or antrum of Highmore. This cavity is of a triangular form, and its closure is completed by certain other bones entering into the formation of the skull. The superior maxillary bone gives passage to a branch of the fifth pair of nerves through a small round opening immediately under the orbit, and enters into the

formation of the nose in conjunction with the same bone on the opposite side.

The lower jaw is formed by an arched or horse-shoe shaped bone, termed the Inferior Maxilla or inferior maxillary bone. It is divided into a horizontal portion, containing the lower teeth, and an upright or ascending portion, terminating in the joint or temporo-maxillary articulation at each side. These portions are named respectively the horizontal and the ascending ramus of each side, the chin being considered as placed between them in front. The ascending ramus on each side is bounded superiorly by two structures, viz., in front by a sharp and thin process of bone termed the coronoid process, and behind by another process of a thick and somewhat tuberose aspect, termed the condyle, and constituting the articular portion of this bone. Between the coronoid process in front and the condyle behind, the flat substance of the ascending ramus is hollowed into a deep notch called the sigmoid notch. Proceeding downwards, we find the internal aspect of the ascending ramus perforated by a canal opening downwards into the substance of the bone. This is the inferior dental foramen for the transmission of a nerve and

blood-vessels into the body of the bone for the supply of the contained teeth, &c. At its lower and back part, the angle formed by the commencement of the horizontal ramus is termed the Angle of the jaw, and passing forwards from this on each side to the chin, is what has been already described as the horizontal ramus. Midway between the angle and the chin on each side is a small round opening—the mental foramen—and marking the centre of the chin is a somewhat elevated ridge denominated the Symphysis of the lower jaw.

Such, in general terms, and without entering upon any detailed description, are the more characteristic features of the upper and lower maxillæ.

The Alveolar cavities or sockets in which the teeth are implanted in these bones, consist of a series of pits arranged along the free border of each jaw, and into which the fangs of the teeth are accurately fitted. This accuracy of fitting, along with the curved form assumed by the fangs, and the union established by the membranous structures situated between them and the sockets, explain the remarkably firm manner in which the teeth are found fixed in the jaws.

Each alveolar cavity—whether for the single root of such teeth as those having only one fang, or for any one of the fangs of teeth having several—is enclosed by four walls, one situated towards the lips or cheeks, and one towards the tongue or palate, as the case may be in the upper or lower jaw; and besides these, two transverse walls or partitions exist, separating each alveolar cavity from the others. All these walls are perforated by innumerable minute openings for the transmission of vessels, &c., to the outside of the fang, and at the deepest part of the sockets several larger openings exist for the entrance of the nerves and blood-vessels to the pulp cavities of the teeth. The transverse walls or partitions are much less dense in their structure than either the external or internal walls; and the external wall is in nearly all the teeth much thinner and weaker than the internal one.

These peculiarities in the alveolar cavities are important to be kept in mind with reference to extraction of the contained teeth. The exact adaptation of the alveolar walls to the form of the fang lodged within them—especially when considered along with the curvature so generally

assumed by these fangs—will at once indicate the impossibility of removing the teeth from their sockets by a straight pull. On the other hand, the thinness of the external alveolar wall—coupled with the fact that, like the stones forming an arch, the fangs of all teeth are thickest on their outer aspect—indicates that a force applied so as to dislodge the teeth in an outward direction, will tend very materially to facilitate their removal. In the same manner, the soft and spongy texture of the transverse partitions of the alveolar ridge renders it apparent how, in using the elevator or tooth-punch, a root or stump will be easily extruded, on these walls or partitions yielding before the power of such an instrument when properly directed. The disadvantages, again, attending an unacquaintance with such matters are too obvious to require any comment here.

The anatomical configuration of the teeth themselves, implanted in the upper and lower maxillæ, differs very much among the individual members of the series, and according as they are temporary or permanent. The four incisors of the upper jaw are single-fanged teeth, and they differ from the corresponding teeth of the lower jaw, inasmuch as, while the upper ones

have round fusiform fangs, the lower ones have the fang very much flattened from side to side. The eye-teeth or Canines, possess longer and stronger fangs than any of the other teeth. The form of these fangs is a somewhat flattened cone, frequently marked on the sides by a deep groove or furrow—a construction rendering their fixation in the jaw very secure. The Bicuspids in the upper jaw—two in number on each side—have their fangs either single and very much flattened from side to side, or this flattening so pronounced in the middle as to divide the otherwise single fang longitudinally; thus leading to the tooth having two fangs—one externally and one internally—both in such cases being generally round and attenuated. In the lower jaw, the corresponding teeth have simple round tapering fangs, sometimes of considerable length. The Molar teeth of the upper differ in an important respect from those of the lower jaw. The upper molars have three fangs; the lower have only two. The three fangs of the upper molars are arranged so that two shall be situated next the cheek—one fang behind the other—and the third fang placed inside the others and directed towards the palate. In this

manner the upper molars possess one palatal and two buccal or cheek fangs, the palatal being the largest, and next to that the anterior buccal fang. The lower molars possess two fangs, one placed behind the other, and of these the anterior is markedly the largest. The fangs of the lower are generally much broader and longer than those of the upper molar teeth.

A difference has been stated as existing between the form of the temporary contrasted with that of the permanent teeth. This is not confined merely to the size of the permanent teeth being so much greater than that of the deciduous set; but the temporary teeth are peculiar in two respects—first, they have the crown very much contracted at its junction with the fang or fangs, so as to cause a bulging or shoulder at that part where the tooth rests upon the gum; and second, in all the multiple-fanged teeth in the temporary set, the fangs are spread much more widely, and their separation increases much more rapidly towards their extremities than is the case with similar teeth in the permanent series. Both these peculiarities will be found of some service to be kept in mind in grasping a temporary tooth, and in proceeding to its extraction.

MAXILLARY MUSCLES AND TEMPORO-MAXILLARY ARTICULATION.

Before proceeding to describe the muscles moving the lower jaw, it may be stated that its movements are those of—1*st*, depression, by which the mouth is opened; 2*d*, elevation, by which it is closed; 3*d*, a backward and forward movement; and 4*th*, a lateral movement, or a motion from side to side. In order that motions of this kind should be practicable, the joint or articulation of the lower jaw with the temporal bone is found to present certain peculiarities. This joint is formed by the Condyle of the lower jaw articulating with a hollow in the temporal bone—termed the Glenoid fossa. The ligaments by which the joint is held together are three in number, namely, the External lateral ligament, consisting of a band of fibres covering in the articulation on its outer aspect; the Internal lateral ligament, a fibrous band extending from a structure in the neighbourhood of the joint—termed the Spinous Process of the sphenoid bone—downwards until it is inserted midway down the ascending ramus on its inner side, at the inferior dental foramen; and the Capsular

ligament—consisting of a few ligamentous fibres passing from the edge of the glenoid cavity to the inner and back part of the neck of the condyle. Between the surface of the glenoid cavity and that of the condyle, there is interposed a flat oval disc of cartilage termed the Inter-articular Cartilage. This cartilage is freely movable, shifting its place with the various motions of the joint, and is lubricated on its upper and under surfaces by two structures placed one in each of these two situations, and termed synovial Membranes,—their purpose being to secrete an oily fluid called Synovia. Such is, in general terms, the construction of the temporo-maxillary articulation at each extremity of the lower jaw.

Muscles are bundles of fleshy fibres constituting the organs by which the movements of joints are effected. Their size varies to a great extent, according to the power they have to exercise; and their colour and consistence is that of what we recognise as flesh. The maxillary muscles may be divided into two groups—those designed for closing and those designed for opening the jaws. The group to which attention is here chiefly required is that of the

muscles closing the jaws, as the muscles employed in opening them are not confined in their action to this purpose alone, but are connected as well with the movement of other structures in front of the neck. They may therefore be dismissed by merely stating that they are attached to the inner surface of the horizontal ramus, principally to the inner surface of that part forming the chin; that they are in a great measure associated with the movements of the tongue and other parts, and that they form to a considerable extent the floor of the mouth.

The other muscles, those adapted for closing the jaws, form the more active agents in the process of mastication, and are five in number, namely, the Masseter, the Buccinator, the External Pterygoid, the Internal Pterygoid, and the Temporal Muscles.

The masseter is a thick square-shaped muscle, composed of a deep and superficial layer, and arises from the superior maxilla, the malar bone, and the zygoma; from these it descends to the ascending ramus and angle of the lower jaw, where it is inserted. This muscle, from its situation and direction, closes the lower molar teeth with great power against those of the

upper jaw. The buccinator is a muscle acting principally on the cheeks, and enabling them to assist the jaws during mastication. It arises from the alveolar surface of the superior maxilla and from a corresponding part of the lower jaw, over a space extending from the pterygo-maxillary ligament behind to the bicuspid teeth in front. Its fibres converge until they meet and cross each other near the angle of the mouth. The external pterygoid muscle arises by two heads; one from a structure termed the pterygoid ridge of the sphenoid bone, the other from the external pterygoid plate of that bone and part of the palate bone. It passes backwards to be inserted into the ascending ramus of the lower jaw immediately under the condyle. This muscle acts as a grinding and bruising muscle, by drawing the lower jaw forward upon the upper. The internal pterygoid is a thick muscle arising near the external pterygoid from the pterygoid fossa, and descends to be inserted on the inner surface of the ascending ramus near the angle of the jaw. The temporal is a somewhat extensive fan-shaped muscle arising over a large portion of the side of the head; its fibres converging to be inserted by a strong tendinous

attachment into the coronoid process and along the inner surface of the ascending ramus. Its action is that of closing the lower against the upper jaw.

All these muscles act in concert during mastication, and their combined action results in the rotatory or grinding movement by which the food is crushed and triturated between the teeth.

BLOOD-VESSELS SUPPLYING THE TEETH AND ADJACENT STRUCTURES.

The blood-vessels in an animal body are composed of Arteries, or those vessels conveying the blood from the heart to every part of the body; of Veins, or those vessels returning the blood from these parts to the heart; and of Capillary vessels, or those minute branches which ramify through the tissues, and form the ultimate channels through which the blood passes from the arteries into the veins. The arteries commence at the heart by a large main trunk, termed the aorta; from this trunk branches are given off, and from these again other branches, and so on until the capillaries are arrived at.

It will be sufficient, in describing the arteries

of the teeth, to go back to that branch termed the Carotid artery. This artery divides into two minor branches—the External and the Internal carotids. The external carotid ascends along the side of the neck, and behind the ascending ramus of the lower jaw, until passing upwards it terminates by being distributed over the surface of one side of the head. This external carotid gives off many branches during its course, and it is with one of these we have here to deal, namely, the Internal Maxillary artery.

This artery rises from the external carotid, at a point on a level with the opening of the ear. It then passes forward, dips behind the condyle of the lower jaw, and turns inwards between the two heads of the external pterygoid muscle; while passing within the condyloid portion of the lower jaw it gives off a branch to supply the teeth of the lower jaw, the Inferior dental artery. This artery passes downwards to the dental foramen, and proceeds along its canal until it reaches the mental foramen, where it subdivides into two branches, one of which escapes by the mental foramen, and is distributed on the surface of the chin and face; the

other branch continuing its course forwards within the substance of the jaw, to supply the lower incisor teeth. On the internal maxillary passing between the two heads of the pterygoid muscle, it gives off another branch for the supply of the teeth in the upper jaw, the Superior dental artery. This artery descends upon the back of the tuberosity of the superior maxillary bone, and sends a number of branches through several small openings there, to supply the posterior teeth, and to be distributed within the antrum. Another branch of the internal maxillary passes through the canal described as situated immediately beneath the orbit in the upper jaw, the Infra-orbital artery. This artery, as it runs along that canal, sends branches downwards, some of them to supply the lining membrane of the antrum, and some of them, the anterior dental arteries, to supply the incisors and teeth in the fore part of the upper maxilla. All these arteries interlace and communicate with each other and with adjacent arteries in a very general and extensive manner; so that should one of them be obliterated, the supply of blood to any part would be but little impeded. Each artery has, generally speaking,

a corresponding vein or veins; but sometimes it becomes difficult to follow out this arrangement. The veins carrying the blood from the head and corresponding to the carotid arteries, are termed the Internal and External Jugular veins.

NERVES SUPPLYING THE UPPER AND LOWER MAXILLÆ AND TEETH.

The nervous system consists of the brain, the spinal cord, and numerous white bands or filaments of nervous substances, termed nerves. In addition to these is what is called the sympathetic system of nerves, a series of numerous small masses of nervous matter, termed Ganglia, and filaments communicating with them and with the brain and spinal cord. Thirty-one pairs of spinal nerves are described by anatomists, and nine pairs of cranial nerves, or of nerves arising from the brain. Of these cranial nerves the Fifth pair is that supplying the teeth and dental apparatus generally. The fifth pair of nerves is also termed the trifacial nerve, because three of its principal branches terminate by being distributed from three different foramina opening in the bones of the face, namely, the Supra-

orbital, the Infra-orbital, and the Mental foramina.

All the spinal nerves are subservient both to sensation and motion. Some of the cranial nerves, on the other hand, convey only sensory impressions, while others are only nerves of motion. The fifth pair, however, combines both these functions. At its origin, in the brain, it consists of two portions, termed anterior and posterior. Its anterior portion is motor, and passing forwards, subdivides, and is distributed to the maxillary muscles. Its posterior portion assumes the form of three branches, termed the Ophthalmic, the Superior Maxillary, and the Inferior Maxillary nerves. The ophthalmic nerve emerges above the orbit; the superior maxillary immediately under the orbit, through the infra-orbital canal, in the superior maxilla; and the inferior maxillary emerges by one branch through the mental foramen, in the lower jaw. The branches principally associated with the teeth are the superior maxillary nerve, and that branch of the inferior maxillary emerging through the mental foramen, the inferior dental nerve. Just as it enters the infra-orbital canal, the superior maxillary nerve sends down

several branches, which enter the foramina on the posterior surface of the tuberosity of the superior maxilla, and supply the posterior teeth of the upper jaw,—and while passing along this canal it sends off other branches, the middle and anterior dental branches, which pass down within the antrum to supply the remaining upper teeth. The inferior dental nerve passes down between the two pterygoid muscles, and entering the dental foramen on the inner aspect of the ascending ramus, supplies the teeth of the lower jaw. It passes along the canal in that bone, close to the extremities of the roots of the teeth, from the dental to the mental foramen; at which latter, it divides into two branches, one passing out there, and being distributed to the integuments in the cheeks and chin, the other passing forward to supply the incisor teeth.

These nerves communicate freely with other nerves in their vicinity, and in this way account for the irritation and pain set up in neighbouring parts from disease of the teeth.

MUCOUS MEMBRANE OF THE MOUTH, &c.

The entire cavity of the mouth is, in common

with other portions of the alimentary canal. lined by a structure analogous to the skin covering the external surface of the body, and termed Mucous Membrane. What is termed the Gum, consists of a dense and hard form of mucous membrane, closely adherent to the jaws, and embracing, without being attached to, the necks of the teeth. The gum is endowed with very little sensibility. It is reflected into and becomes continuous with the membranes lining the interior of the alveolar cavities. Several bodies, termed Salivary Glands, are associated with the mucous membrane of the mouth, and aid in supplying moisture, in the form of saliva, to that cavity. These glands are three in number on each side, namely, the Parotid gland, the largest of the three, situated in the neighbourhood of the ascending ramus of the jaw, and opening by a duct, called the duct of Stenon, on the internal surface of the cheek, opposite the second upper molar tooth; the Sub-maxillary gland, situated under the horizontal ramus at its back part, and opening into the mouth by a duct, termed Wharton's duct, terminating under and near the front part of the tongue; and the Sub-lingual gland, situated under the

tongue on each side, and opening by several small outlets near the orifice of Wharton's duct. The whole mucous membrane of the mouth, together with the salivary glands, sympathises largely with the teeth in their diseased conditions, and becomes the seat of many painful affections in irritation of the parts arising from this cause.

In many cases a large deposit of calcareous matter takes place from the saliva, and attaches itself in thick masses to the crowns, or any exposed portions of the teeth. This deposit is termed Tartar. The operation known as Scaling consists in the removal of this substance from the surface—generally the buccal or lingual surface—of the teeth. Instruments for the purpose, termed Scalers, are to be had in a variety of forms. They are used by inserting the point into or under the masses of tartar, and scraping, or if in large quantity, lifting it away, taking care not to loosen the teeth in so doing. Any roughness left after scaling may be removed by rubbing the exposed enamel with powdered chalk on a piece of cane or pointed wood.

CHAPTER IV.

DENTITION: ITS DISORDERS AND THEIR TREATMENT.

DENTITION, in the most common acceptation of the word, appears to be too frequently confined to that period at which the temporary teeth make their appearance above the gum; and in this restricted sense of the term, we have constant reference made to a number of affections occurring during infancy, and attributed to the morbid influence of, exclusively, the eruptive stage of this process, under the various names of teething, cutting the teeth, &c. &c., all having regard to the penetration of the tissue enclosing the tooth—as if this were effected, not according to a vital process, but by mechanical force—while the other stages, exhibiting less obvious phenomena, are never taken into account at all. It is of importance, in the consideration of this subject, to bear in mind that the process of dentition, being in all its stages a natural one

regulated by relatively the same physiological laws as other healthy actions, ought to proceed without constitutional disturbance; that it does so in all animals, so far as we know, with the exception of man; and that, in his case, when disturbance does take place, it is to be regarded as arising from some peculiar abnormal condition of the parts concerned in, and not at all as an inherent effect of, the process itself.

The structures concerned in dentition are originally adapted for its occurrence, and it is inconsistent with what we know to be the case in analogous instances of development, that any of the steps essentially necessary in the process—such as the penetration of the gum—should occasion a great amount of distress. But an important source of error, and one calculated to lead to much misapprehension on this subject, exists in the fact, that from the greater susceptibility at this age to impressions of any kind, sometimes to those of a very slight nature, considerable constitutional disturbance, altogether apart from this cause, is of very common occurrence; and, although certainly not in every case due to this process, yet the eruptive stage of dentition offering something like a plausible

explanation of suffering, an unfavourable impression generally prevails regarding it, and affections are imputed to its agency, which might, in many cases, be traced to an entirely different origin. Attention, however, being arrested by what appears to be so evident a cause of uneasiness, all treatment is at once turned in that direction, and the true cause of the disorder probably overlooked.

While these remarks are advanced as illustrative of the misconception prevailing in reference to the danger resulting from dentition, it is not meant to dispute the fact that important symptoms may exhibit themselves in connection with this process as it occurs in man, but rather to point out that too great anxiety exists with regard to it as a necessary, an unavoidable, cause of suffering; an opinion, if not arising from, at least increased by the obscurity and uncertainty involving the whole process, and extending to those principles upon which its treatment requires to be based.

In considering the nature of the symptoms attending laborious dentition, we must look principally to the organic condition of those textures implicated in the action going on; re-

collecting that the teeth, during their development and rapid growth, while acting in one sense as foreign and partly inorganic bodies within the gum, are endowed with a very high degree of vascularity and sensation, so that whatever pressure they may exert on contiguous parts, re-acts upon themselves with still severer effect, that again being aggravated in its consequences by the condition of the whole nervous system at this period of life. Whatever complications may arise as secondary consequences of dentition, pain seems to be its most frequent as well as its most simple accompaniment, and it is to the immediate causes of this condition, as mainly productive in its results of those maladies observed to be more common about this age, that attention has been so often directed. Locally, the inconvenience seldom exceeds mere irritation; that, however, sometimes increasing to a considerable extent; and although almost universally asserted, it seems not to be satisfactorily established, that this arises merely from the cutting or penetration of the teeth through the superincumbent tissues, but also from other circumstances connected with the development of these organs during the first dentition. In

children at this age, the manifestations of pain, when it is present, are unmistakable, although it becomes a very difficult matter in many cases to assign to such pain an exact locality. Pain, when associated with the tooth germs, may be either of a neuralgic or inflammatory nature. Where it seems transitory or intermittent, it is probably neuralgic; where it is persistent, and especially if accompanied by swelling, heat, or redness of any part of the gums, inflammatory action is, of course, evident. It is in either case, however, comparatively unimportant, so long as the evil is confined to the mouth. When it reacts upon the general system, and leads to functional derangement, interference of some kind becomes necessary.

If no indications of inflammation exist in the mouth—and no tooth may, according to the natural course of events, be expected to appear for a considerable time—some substance should be given the child to rub against its gums, care being taken that such substance should not be of a nature calculated to lead to danger by breaking or passing into the mouth—such as crusts of bread, small keys, coins, and the like. In this way, two indications may be fulfilled,

namely, first, an increased flow of saliva is produced, and a derivative action, as well as a kind of fomentation, to the parts is obtained; and second, the alveoli and gums seem to be rendered thinner by such means, probably by the friction and pressure accelerating their absorption.

Where, on the other hand, the gum is red or hot, or appears tense and stretched by the pressure of the crown of the tooth beneath, more active measures may be employed. The chief of these is what is termed Scarification. This consists in making an incision down upon the growing tooth, the object being to relieve congestion existing in the highly vascular tissues concerned, and sometimes to facilitate the egress of the tooth, by dividing any bands or bridles of tough mucous membrane opposing its escape. The method of performing this little operation in the easiest manner will be found to be that of seizing the affected part of the gum betwixt the thumb and forefinger of the left hand, and by means of a sharp-pointed, curved, and somewhat short bistoury—that known as Syme's abscess knife being the most suitable—making a crucial incision completely through the tissues

covering the tooth. There seems little doubt however, that although this proceeding may in one way be beneficial, in another it is possible to be injurious; because, while good results may follow in the manner already specified, yet the delicate structures involved in the still rudimentary condition of the tooth must be, to a certain extent, interfered with. It should, therefore, be adopted only as a last resource, and after mature consideration. Where apparently causeless convulsions, for example, occur during the active stage of dentition, or where the eruption of previous teeth has been uniformly attended with much suffering, less hesitation may be necessary; but in other cases some local evidence of irritation should always be present before having recourse to such practice. And one other point to be mentioned is, that some attention must be paid to those periods in the process of dentition when the various teeth may be naturally expected to make their appearance; because it is at such periods that this operation is most likely to be attended with benefit.

The temporary teeth are not subject to Irregularity in their arrangement. This, on the other hand, is a very common occurrence among

the members of the permanent set. The most marked forms of irregularity seem to occur in the front part of the dental series; generally among the teeth anterior to the bicuspids. Sometimes the irregularity is confined to mere crowding and displacement of the teeth in one or other jaw; sometimes it leads to more perceptible deformity, such as projection of the the under teeth beyond the upper, leading in this way to the patient being what is termed under-hung.

The treatment of dental irregularity consists of two kinds,—first, that of providing sufficient space to accommodate the teeth in their regular order; and, second, that of forcing them into their natural situations when such space has been provided. The first step, then, being to obtain space for the displaced teeth, it generally becomes necessary for this purpose to extract one or more at some part of the mouth. The question is, which teeth to select for removal? and the following rules may serve so far as a guide in this respect.

1*st*, Where the corresponding tooth of the temporary set is present, it of course is to be at once extracted; and where any of the tempo-

rary series seem to be directly in the way of any of the permanent set which have just appeared, such temporary teeth should be removed.

2*d*, The canine teeth not being renewed until those situated behind them, the bicuspids, have appeared, are subject to great irregularity in position; but of all other teeth they resume their place with the least amount of interference. If, however, the anterior bicuspid threatens to leave too little space for the canine, both temporary molars of that side should be extracted, and the temporary canine preserved as long as possible, as this tooth serves to keep a space vacant for its expected permanent successor.

3*d*, Where all the temporary teeth are already removed, the first or anterior permanent molar is the next to be sacrificed, as this, of all the permanent set, is the one most subject to be lost.

4*th*, Lastly, in such cases as those where it seems hopeless to expect that sufficient space will be gained by the removal of teeth at a distance from those to be regulated, such of these irregular teeth themselves as seem least serviceable, and most likely to facilitate the re-arrangement of the others, must be removed; always bearing in mind, that the canines are

perhaps the most durable, and in that respect consequently the most valuable, teeth in the whole series, and the first molars the least so.

When sufficient space has been gained, the displaced teeth may be forced into position in a variety of ways. The principle upon which all of them, however, are founded, consists in a plate of metal, or other material, being accurately fitted to the palate or jaw, and so securely fastened in its place as to afford a fixed point from which the displaced teeth may be acted upon, either by being pressed into their place by little wedges, and such like means, or being dragged into it by the use of ligatures; considerable time—some months generally—being required for the accomplishment of such an object, in whatever mode it may be attempted.

As the making of such plates requires all the experience of a regular mechanical dentist, it seems unnecessary here to dilate upon their construction. What chiefly devolves upon the surgical practitioner is, to see that such plates, when supplied, are continuously worn, and to impress upon the mind of the patient and attendants the length of time required for effecting those ends for which their use is intended.

CHAPTER V.

DENTAL CARIES, NECROSIS, AND EXOSTOSIS; ALVEOLAR ABSCESS AND FUNGUS OF THE PULP.

THE pathological conditions under which the dental tissues are met with, naturally seem to arrange themselves under two separate heads. First, those where a morbid development of new tissue occurs; and second, those where the normal tissues of a tooth become deteriorated or destroyed. Exostosis of the fang may serve to exemplify the first, and dental caries may be taken as illustrative of the second of these divisions.

The ordinary characters of caries are in general familiarly understood. It consists in a diseased condition of the dental tissues, especially of the Dentine, whereby it becomes disintegrated and disappears, leaving a large, softened, and discoloured cavity in the tooth, which, when left to itself, ends in the crumbling down, and total loss of the whole crown, and frequently of the greater

portion of the fangs. At its earliest stages this affection usually attracts little or no attention. This arises from the small amount of sensibility existing in the dentine of a previously healthy tooth. Considerable morbid change may here however, as in other tissues, take place without pain, and its occurrence thus be overlooked. Generally a slight discoloration exists at the site of the disease from a very early period. A dark spot or streak appears on some part of the enamel, very often at some part where it is thinnest, such as in the hollows of the crown of a molar tooth, or where the enamel becomes attenuated as it approaches the fang. At such points the flaw becomes more and more apparent; the enamel assumes a friable and undermined appearance; and at some unexpected moment, this structure gives way more or less and reveals the altered dentine below; a state of matters probably up to this time unsuspected. From this period the distinguishing characteristic of dental caries, in contrast with that of other osseous tissues, is manifest, namely, the essential part played by chemical action from without, in addition to those changes going on from within—vital becoming combined with

mere chemical action, and the tissues of the tooth being literally decomposed. Pathological changes render the substances of the tooth open to the attacks of chemical agencies existing in the secretions of the mouth, and by these last the calcareous matters of the diseased structures are dissolved and washed away. The structure chiefly and primarily affected is generally the dentine. Very soon, however, the enamel suffers, and frequently the cement also becomes involved in the disease. Sometimes these two latter structures appear to be first affected. There seems less reason to doubt the likelihood of this being occasionally the case with the cement, but the nearly inorganic nature of the enamel would almost preclude the idea of any lesions primarily occurring there being of a vital nature. More probably, where this substance is affected in the first instance, it does no more than favour or excite the commencement of true caries in the dentine beneath.

Besides these somewhat anomalous characters presented by dental caries during its progress in individual teeth, there are certain peculiarities manifested by it in the manner in which it spreads among the various members of the den-

tal series. Certain teeth, such as the first lower molars, are much more liable to its attacks than others, and it generally attacks in a uniform manner corresponding teeth on both sides of the mouth. Frequently the disease suddenly commences and goes on in a series of successive attacks for some months, or even a few years, until a number of teeth have been destroyed, when it suddenly and inexplicably disappears, and perhaps recurs no more during a lifetime. At other times, in cases where one or two obviously defective or perhaps injured teeth exist in a mouth, caries will appear in some altogether unlooked for quarter, leaving the suspected teeth unmolested. Most commonly it prevails to the greatest extent in young persons, but its ravages sometimes commence almost as soon as the temporary teeth appear, and sometimes its first attack occurs only in advanced life.

Different theories have been advanced regarding this peculiar disease; but unless it be considered as partaking of the character both of a constitutional affection and of a lesion produced by local causes, it seems difficult to account for its somewhat exceptional if not

unique phenomena. According to one theory, dental caries is set down as an exclusively chemical process, a mere decomposition of the dental tissues. According to another, it is a purely vital action, consisting in gangrene or mortification of these tissues—neither view, however, seeming to be correct.

From what has been stated in another chapter regarding the development of the teeth, it will be recollected that they are originally formed from mucous membrane, that modification of skin which lines the alimentary canal from the mouth downwards. The germs of these organs were described as being developed in the groove found in the mucous membrane of the fœtal mouth. We must therefore consider teeth as dermal organs; organs analogous to such appendages as nails or hairs, and consequently we may naturally expect them to be subject to attacks of disease such as are associated with other dermal tissues. In this manner, there is no reason for considering that dental decay is an exclusively chemical action; a mere decomposition of the substance of the tooth by the action of the oral fluids. Were this the case, all teeth would be equally affected,

which we know does not occur. And even if, as has been advanced, such chemical action only occurred in exposed or defective dentine, we should find broken, or worn down, or obviously defective teeth suffering more than others; which, again, is far from being invariably the case. But if we admit the accession of disease as possible in *any* tooth, however healthy or well developed, we get rid of the difficulty, and obtain a sufficient explanation of many otherwise inaccountable facts connected with this subject. Indeed, if it be held that defective development is a necessary condition for the inroad of decay, we admit that at an earlier period of the tooth's existence, the vital functions of its tissues have undergone a lesion apart from the direct action of any external causes. And if development may thus be interfered with, that is, if the nutrition of a part can be arrested or altered during its growth, there appears little difficulty in extending the proposition to its nutrition at a later period being liable to somewhat similar disturbance, leading to its vitality being diminished, and disease thus established without the intervention of any extraneous cause. The vitality of a fully developed tooth is now an undisputed

fact; and being vital organs, they will be at any period subject to disease originating from within, as well as injuries occurring from without. Many phenomena, in the accession of dental caries, bear out such a statement. The direct sequence of such an affection on various temporary conditions of the body, and of organs in no way directly associated with the teeth, is more than sufficient proof of this. The effects on them of many constitutional disorders—of mercury—of pregnancy—even of disorders of the nervous system, such as during insanity, clearly demonstrate how very much these organs are influenced by causes which must act upon them not physically, but physiologically, and consistently explain away many or all the difficulties attaching to the older theories of dental caries.

There seems little doubt, then, that this disease may be and is originally a vital action set up in the dental tissues, whether these tissues be congenitally defective or not. Where defect does exist, dental decay may be favoured and accelerated by such circumstances; but it does not follow that decay cannot attack a perfectly sound and well-developed tooth. On the other hand, injurious results approximating true caries

may arise from local causes; but where a mere local cause is at work, as in disordered secretions within the mouth, either its effects will not be confined to one or two teeth, but will extend equally to all without distinction, or it will confine itself to mere chemical decomposition of such individual teeth as come, in some obviously exceptional manner, under its influence. Such an effect, however, would fall more correctly under the head of chemical decomposition than of disease considered as a pathological lesion, and fails to account for the vital phenomena displayed in the selective progress, the various morbid changes, remarkable intermissions, &c., in decay, already alluded to. While the first molars seem to be the teeth most liable to caries, the lower incisors are those least so. No satisfactory explanation of the prevalence of caries in certain teeth more than in others has ever been given; but the immunity of the lower incisors may probably be accounted for by the presence of the Saliva lodging in larger quantities in their vicinity. And this is a circumstance deserving of some attention. Wherever the saliva lodges to the greatest extent, there we find the largest deposit

of what is known as Tartar or salivary calculus, as it in reality is; and wherever such substance is found to be most abundant, there decay will be found to be most rare. This is well exemplified in the case of the lower incisors. Here the saliva lodges continuously, and in considerable quantity; and the result is that the greatest accumulations of tartar are always to be met with in this locality. Now, of all other teeth the lower incisors are least affected with caries, those of the upper jaw being, on the other hand, very liable to this disease. The explanation here, then, seems to be, that the peculiar alkaline character of the saliva neutralises any acid which might be otherwise conducive to the loss of these teeth, and in this way serves as a defence in some measure against local agencies of a destructive character to these organs.

Such, in general terms, appears to be the nature of dental caries, by far the most common disease to which the human teeth are liable, and the loss occasioned by which is so great. The question may be asked, If dental caries be a true pathological lesion, why is it that no healing process is set up by nature, so that the ravages of such disease should be at least in

some cases spontaneously checked, if not repaired? That such an attempt is made by nature has been shown to be the case. The microscope has revealed a condensation of the dentine which occurs around a carious cavity, manifesting an effort on the part of nature to limit the extension of the disease. But in the majority of cases among other organs than the teeth, it must be recollected that whatever healing effort may be made by nature, it would have little chance of being successful were the diseased part subjected to the same exposure as is the surface of a carious cavity in a tooth. Here the diseased action is kept up, as would that of an ulcer in the skin, unless properly protected; and it is with such a view, and on such a principle, that in cases of dental decay the operation of stopping or filling the tooth is adopted.

Besides caries, two other affections of the teeth render their removal in many cases necessary. From various causes, such as blows, inflammation of the alveoli, &c., a tooth may be deprived of the little vitality it naturally possesses, and in this way it may, without much alteration, become Necrosed, or what is the same thing, it

dies. Such necrosed teeth lodging in the socket act as foreign bodies, and often give rise to much irritation; in such cases they are always better removed at once. Sometimes a tooth is only partially affected with necrosis; a part of it is deprived of its vital supply and dies. Here the irritation set up by the presence of a partially dead tooth may not be so great; but the gum is very apt to be absorbed, the alveolus to become filled up, and the tooth to be extruded from its socket. Necrosis in many, although not in all, cases, may be detected by the uniform, dark, somewhat horny appearance generally assumed by teeth so affected. If such teeth excite no irritation, and are in any way useful, they need not be extracted; but if any irritation is set up by them, the only remedy is their removal.

Exostosis is a diseased condition very common among teeth, and the results of which occasion much annoyance of various kinds. The disease consists in a thickening of the substance coating the fangs, and already described as the "cement." This thickening may be general when it assumes the appearance of uniform enlargement of the root of a tooth, or it may be

partial, and manifest itself in the form of nodules or projections of various kinds upon the surface of the fang. The principal evil effect produced by it is pain, and this is by no means confined to the seat of the disease, but may occur in the neighbourhood of other teeth, or in the chin, or cheeks, or even in localities still more distant from the exciting cause. Its detection is difficult, as no reliable indications of its presence are known. As it is generally, however, in diseased teeth that it commences, some suspicion ought always to attach to such teeth where unaccountable pain occurs in their vicinity, whether they themselves may suffer from tenderness or not. Here, again, extraction is the only remedy, and will be in all probability easier to perform early in the disease, because the deposit of new cement being originated by some irritation in the tooth, continues to increase so long as any irritation lasts; and if of the nodular form, such deposit may fix the tooth more and more immovably in its socket, by each nodule making for itself a depression in the interior of the alveolar walls.

Such are the diseases by which the greatest loss of teeth is occasioned. In necrosis and exostosis, extraction, indeed, is perhaps the only

remedy. In caries, the tooth may frequently be saved, provided the disease be treated early, by the cavity being filled up and protected in the manner afterwards to be described under the head of Stopping.

Alveolar abscess or gum-boil arises from the periosteum lining the alveolus becoming inflamed, and suppurating. The matter makes its way through the alveolar wall, and lodges beneath the gum, forming the swelling characteristic of this disease. Among other causes, the irritation set up by decayed teeth is a prolific source of such affection. Warm fomentations, and opening the abscess, may here act as a palliative remedy, but the proper measure is extraction, as, by continuous irritation, such cases are apt to lead to sinus opening on the cheek, &c.

Another affection, also in most cases demanding extraction, is where Fungus of the pulp occurs, and appears as a red pouting mass protruding from the orifice, or projecting into the bottom of deep and large cavities in teeth where caries has been of long standing. Touching the mass with nitrate of silver may occasionally lead to its disappearance, but removal of the tooth is here also the more certain cure.

CHAPTER VI.

EXTRACTION, AND THE INSTRUMENTS EMPLOYED.

THE principal points to be attended to in Extraction are the proper seizure of the tooth, and its detachment from the walls of its socket in that direction where least resistance is likely to be met.

In seizing a tooth, whatever instrument be employed, the part upon which a hold is taken must be of sufficient strength to withstand the force necessary for dislodging the fangs. In order to obtain such a sufficiently strong portion of a decayed tooth, a part beyond the decay must be sought for. As the decay, however, frequently extends so deeply that it encroaches on those parts lying deeper than the neck of the tooth—as where the whole crown is entirely gone and a deep cavity still exists in the remains of the tooth left in the gum—the part to be grasped by an instrument will lie beneath the

margin of the gum, or even that of the alveolus. The instrument must consequently be thrust with considerable force within these structures, until it reaches a firm and sound part of the tooth, and there be made to grasp it securely, but cautiously. In reaching this part some difficulty will occasionally be met with. Where the decay has advanced on one side,—or it may be on more than one side,—below the level of the alveolus, the instrument, instead of fixing itself beyond the decayed cavity, will be very apt to slip into it, and thereby break down the remains of the tooth. And again, when the alveolus is of dense and hard consistence, or where its walls are very thick, as is often the case in the neighbourhood of the lower wisdom-teeth, it often becomes a matter of great difficulty to insert an instrument between the surface of the fangs and the socket enclosing them. Where the walls, again, are thin but dense, and firmly attached to the fangs, they are, on the other hand, apt to be seized along with the tooth, and to increase the difficulty of its removal.

The detachment of a tooth from the alveolar walls surrounding it should, as has been already said, be made in that direction where least

resistance may be expected. A tooth cannot always be drawn perpendicularly from its socket. Except in occasional instances of single-fanged teeth, the roots converge or diverge, or are bent in such a manner that they would be broken across before they could be removed by a straight pull. Moreover, even when the fangs are single, and not at all bent or distorted in any way, the firmness of their attachment is so great, that the amount of force which would be required to dislodge them by a straight pull would be more than could generally be applied by the hand, and would be unnecessarily severe for the patient, as it would be injuriously diffused over parts at a distance from the tooth to be removed. It is of course impossible to tell beforehand what direction or what irregularity the fangs of a tooth may possibly assume, so that, instead of attempting to take such minor details into consideration, it will be found more expedient to take advantage of some general characters which may be said to be universally present in the conformation of the teeth and their containing alveoli, and to conduct their extraction accordingly.

The fangs of all the teeth are, as has been previously described, a little broader at their external

than at their internal edge or border, consequently they may be moved outwards much easier than inwards. Again, the external wall of the alveoli is much thinner and weaker than it is internally, consequently the external wall yields much more readily than the internal one. And, coupling these two facts, it will be seen that a tooth will be much easier dislodged by a force applied in an outward and downward, or in an outward and upward, direction in the upper or lower jaw respectively, than by any other mode. There is, however, an exception to this rule, and that is in the case of the lower wisdom-teeth; the external plate of the alveolus being in their case very much increased in thickness by the strong ridge passing down from the coronoid process of the lower jaw. As these teeth, however, are comparatively small and not generally very firm, this disadvantage is so far counterbalanced.

Keeping these facts in remembrance, the extraction of any tooth becomes much simplified, and the form of instrument most suitable for the particular case can easily be selected. Where all or most of the crown of a tooth remains intact, extraction ought to be performed with

Forceps. The blades of such forceps must be adapted to the particular tooth in two ways,—first, they must be so bent as to reach it easily; second, their edges must be so shaped as to be easily inserted within the alveolus. No one pair of forceps can possibly be thus adapted for all teeth,—the great variety in size, form, and situation of the different teeth rendering this impossible; and although all teeth *can* perhaps be got out with a bone-pliers, or even with a common brad-awl,—a mode in which the resurrectionists used to practise with profit and success,—yet such methods of extraction are necessarily severe and imperfect. Five pairs of forceps will be found serviceable for most purposes, and fewer will not. These are a straight pair, and a pair with the blades nearly at right angles with the handles, both of which will be required for upper and lower roots and single-fanged teeth; a pair adapted for the lower molars, and two pairs for the upper molars—one for the right and one for the left sides. Many other forms would be desirable, and may be collected, but these five pairs will be found absolutely necessary. It has been stated that the blades at their extremities should fit that part

of the tooth they are intended to grasp. In this way it will be seen that for single-fanged teeth these blades will merely require to be adapted for the oval form presented by a transverse section of such fangs—hollowed out, in fact, so as to apply themselves more closely to their surface. For multiple-fanged teeth, the forceps must also be, on the same principle, adapted to the form of the surface to which they are to be applied. One pair will be found to answer for the double-fanged molars of the lower jaw, but for the three-fanged molars of the upper jaw two pairs will be necessary, as these three fangs are always so placed that two of them are next the cheek and one towards the palate; consequently the forceps which would fit one side will not at all fit the other. With this number of forceps properly constructed, almost any case of extraction may be undertaken where forceps can be used at all.

But there are cases where forceps are unserviceable. In many instances where stumps are causing irritation, or require removal, they are so far decayed as to be altogether beyond the reach, or too friable to admit of the use, of any grasping instrument. In such cases recourse

must be had to what is termed the Lever, Elevator, or Tooth-punch. This most useful instrument exists under a variety of modifications, but in all its principle consists in an instrument terminating in a strong spoon-shaped or sometimes spear-shaped blade, from a quarter to fully half an inch long, intended to be thrust down between the stump and its containing socket, wherever a proper purchase or fulcrum can be obtained, and by which, in the manner of a lever, the remains of the tooth can be extended from the alveolus. One or more of these instruments ought always to be at hand in every case of tooth extraction ; and their mode of use is so simple, that to attempt describing the infinite variety of modifications which may be followed in their application is unnecessary. The chief point to be attended to is, that such instruments be not allowed to slip, as considerable injury might thus be done to the cheeks, tongue, or other structures within the mouth.

Another instrument, formerly much more employed in tooth extraction than it is now, is the Key. This instrument, from the immense power possessed by it, is liable to abuse in its application. Its form is too well known by all who

are likely to be interested in these remarks, for any description of it to be here required. Suffice it to say, that when judiciously handled and restricted to such cases as really demand its use, the key is of very great service indeed, and to discard its employment altogether, would be relinquishing an instrument which, in certain cases, no other could replace for simplicity and effectiveness. The cases in which the key is principally useful are those where the forceps incline to break down the remainder of a tooth without obtaining a sufficient hold for its removal, and where, on the other hand, the elevator would be applied at a great disadvantage for want of sufficient purchase. Such a case may be exemplified by the circumstances of the remains of a molar tooth, upper or under, requiring removal, while as yet not only firmly impacted in the jaw, but tightly jammed between the adjoining sound teeth, especially where the decay has been extensive and deep on one or other side of the neck of the tooth, leaving the outer or inner wall tolerably sound. In such a case, by fixing the claw on the sound side of the tooth, and turning it out in the opposite direction, it will in most instances be removed more easily

and expeditiously by the tooth-key than by any other instrument whatever.

By attention to such matters—to the form of the tooth—to the part where it is seized—to the direction in which it is moved—and to the construction of the instrument employed—tooth extraction becomes very simple. Any hurry is inexpedient in the operation; the eye and the hand should have sufficient time to enable the operation to proceed according to what is observed or felt; and it may be laid down, that whenever the tooth is felt to be started from its attachments, be it ever so little, all the severity of the operation is over. Keeping in view, then, these general principles, their application in the extraction of each individual tooth will vary to a certain extent, but will be easily understood if the anatomical peculiarities of the tooth to be operated on be borne in mind.

The incisors of the upper and lower jaws are seldom extracted before these teeth are either loose or reduced by caries to a condition little better than that of stumps. This latter condition is much more common in the upper than in the lower jaw; as the inferior incisors are in far the greater number of instances lost by be-

coming merely loosened and extruded from the socket. In extracting the upper incisors by means of forceps, the round and conical fang permits of their being rotated at the time of their being also pulled downwards and slightly outwards from the alveolar cavity; but in the lower incisors, the movement for their extraction must be confined to that of bending them steadily outwards, or rather forwards, at the same time that they are forcibly raised from their socket; as from the flattened form of the fang, any attempt at rotation here would lead to the tooth being broken. Sometimes, however, as from advanced caries in the upper, or from great crowding among the lower incisors, the forceps cannot be employed. In these circumstances, recourse must be had to the elevator. The mode of using this instrument for the removal of single fangs of any description is much the same; the principal variations in its application arising from the difficulty of access to some situations in the mouth. For removing the fangs of the upper incisors a straight-pointed elevator should be employed. It should be inserted nearly parallel with the long axis of the tooth, with its flat or hollow

side next the stump to be removed; and with considerable force, and by a semi-rotatory boring motion, be made to insinuate itself deeply alongside it, between it and the adjoining root or tooth. The instrument will then probably have obtained a hold or bite upon the stump, which should now, by making the handle of the elevator describe part of a circle, be prised outwards and downwards from its socket. If, after it has been started by the elevator, the fang still adhere to the adjoining tissues, it can be easily lifted away by a pair of straight and slender pointed forceps. The lower incisors have been mentioned as sometimes requiring the elevator to be employed, on account of crowding rendering the application of forceps impracticable. Here the same form of elevator may be used in another method. Instead of inserting it down the alveolus, so as to make it lie parallel with and alongside the fang, it may be inserted diagonally across between the tooth to be removed and the adjoining one. The hollow or flat side of the instrument must be kept next the offending stump or tooth, and, in this position, driven somewhat downwards between it and the adjoining, until a hold can be obtained on the side of

the fang to be extracted, when, by now rotating the handle of the instrument on its long axis, the tooth will be forced upwards and outwards from its socket. In other cases the same steps may be followed as in removing upper stumps.

The canine teeth of both the upper and lower jaw offer great resistance in their extraction. This is best overcome by using a strong but narrow-bladed straight forceps; inserting their points forcibly and deeply within the margin of the alveolus until a firm and somewhat extensive grasp of the fang has been obtained; and then, with a steady and powerful movement outwards and downwards in the upper, and outwards and upwards in the lower, the attachments of the fang will be found to yield, when it can with but little force be lifted from the socket. The employment of the elevator is sometimes required for the removal of these teeth. But except the greater amount of force here necessary, the instrument and its mode of use is the same as has been described in reference to the removal of the incisors. There is one condition, however, in which chiefly the upper canines are occasionally met with where the proceedings for their extraction require to be somewhat modified;

that is, when these teeth are found so displaced as to lie externally to and above those adjoining. The extent of this displacement varies considerably, but in many cases it is so great that, owing to the inconvenience and deformity occasioned, remedial measures of some kind very soon become indispensable. These, in many cases, are limited to extraction of the displaced canines themselves; and this is to be effected, in a large proportion of instances, only by the elevator. Little more than the apex of the tooth may be found well through the gum, while the position and form of the fang is indicated by a projection of the tissues covering it. In these circumstances, it becomes impossible for a sufficient hold being obtained by forceps for the tooth's removal. The best mode of procedure, then, is to make a slight incision upwards—along each side of the crown of the tooth; then, by inserting the point of the elevator at right angles to and beneath the fang, it can be used as a lever to loosen and detach the tooth by lifting it, as it were, with an outward and downward movement, when, from the less complete fixation at this early period of development, it will be found to yield very easily.

The upper bicuspids are in general more firmly fixed than those in the lower jaw. This, coupled with the fact of their fang being commonly much compressed from side to side, and occasionally divided into two slender rootlets, renders them more liable to fracture than the lower bicuspids. The laterally compressed fang of the upper bicuspids renders it injudicious to attempt anything like rotation in their removal; they should be grasped deeply in the socket with a straight-beaked forceps, and steadily moved outwards until they are found to yield, and then, with a straight pull downwards, not with any sudden jerk, however, their extraction may be completed. The fang of the lower bicuspids, again, is long, round, and tapering. They would, therefore, admit of rotation in their removal, but this is prevented by the upper teeth interfering with the necessary position in which an instrument would require to be applied for this purpose. These teeth are therefore best extracted by using a forceps with long and slender beaks, bent at right angles, or nearly so, to the handles. The beaks should be deeply sunk on the labial and lingual sides of the fang, when, by moving the tooth slightly outwards

and inwards, it will generally start upwards between the blades of the forceps without further trouble. Sometimes the stumps of bicuspids, both upper and lower, require the elevator to be used for their removal; but the principles upon which this is to be done are the same as those for such single-fanged teeth as the incisors and canines, already alluded to.

The molars of the upper and lower jaws differ from each other, as has been already described, in one important point, so far as their extraction is concerned, and that is, in the upper molars possessing, besides an anterior and posterior fang, another single fang directed towards the the palate. In this way the upper molars require a separate forceps for the teeth of either side; whereas one forceps answers for extracting the lower molars of both sides. The molar teeth, both above and below, especially the anterior molars, require great force for their dislodgment. In this manner a very firm grasp has to be made upon them, and, should caries be advanced to any extent, fracture is thus extremely liable to occur in their extraction. This accident is to be obviated by obtaining a hold upon the tooth at as sound a part of it as

can be reached. The points of the forceps blades should be thrust deeply towards the alveolus, so as to lay hold on the fangs—not the neck or crown of the tooth—and then, with a force chiefly directed outwards, the tooth, whether above or below, is to be detached from its connections with the socket. The third molars or wisdom-teeth frequently present characters so exceptional, however, as to render some modification of this rule necessary. These teeth are often found directed outwards or inwards, or forwards or backwards, and in such circumstances their extraction demands a corresponding adaptation on the part of the operator. This, however, can only be, in each individual case, decided on by his own judgment and skill, the general principles of procedure remaining the same. In many cases the key is of invaluable service in removal of the molar teeth; and it is very questionable whether its judicious use causes any greater suffering to the patient; the probability being that it enables the operation to be performed with much less instead of causing increased pain in the majority of instances. The cases where this instrument is of greatest service are those where the labial or lingual

side of the tooth has been entirely destroyed by decay; those, again, where the crown is gone, and where the fangs are so jammed between the adjoining teeth as to render the elevator less applicable; and those where this instrument and the forceps have both failed from any other cause to effect the tooth's extraction. The principal points to be attended to in applying the key are—to have a tolerably sound spot, however small, on either the lingual or labial side of the tooth where the claw can be fixed; to have the bolster or fulcrum steadied, so that it will not slip out of its proper position; and never to apply more force than what ought to dislodge an average tooth. If these directions are followed in conformity with what has been previously laid down respecting this instrument, it will often be found of much use where the forceps or elevators have been unsuccessful. After a molar tooth has been loosened in its socket, there is occasionally some difficulty still existing in completing its removal; and this frequently arises from one of two causes. First, in the anterior molars the fangs are often so divergent as to prevent their passing through that part of the socket originally embracing the neck of the tooth.

or even to clear the space left between those teeth immediately adjoining the one attempted to be removed. And second, in those cases where the crown of a molar tooth has been long decayed to a level with the gum, the adjoining teeth tend to bend and close over the remains of the diseased molar, and to render its extraction liable to be accompanied by loosening or even complete dislodgment of one of its neighbours, especially of the second bicuspid, where this tooth is involved in such circumstances. Where such merely physical difficulties, however, present themselves in the extraction of these teeth, there is obviously nothing except a watchful eye, and a ready hand, on the part of the operator, accompanied with a familiar knowledge of the anatomical form and relations of the teeth themselves, that can be laid down as of universal application for overcoming these obstacles.

Sometimes, after the removal of a tooth, unusually protracted or excessive bleeding may occur from the alveolar vessels. In certain cases—and these are the most to be dreaded—this arises from deficient quantity or defective quality of those constituents of the blood which lead to what is termed its coagulation. Cases of

this kind require medical treatment of a constitutional nature, in addition to local measures for arresting the flow of blood; but the directions for such treatment scarcely fall within the province of a work on Dental Surgery. Where the cause is purely local, however, the treatment will be local also, and may be briefly summed up as consisting of pressure accurately applied and retained for twelve or twenty-four hours in contact with the bleeding surface. The best mode of applying such pressure is by means of a very narrow strip of lint firmly packed into the socket of the tooth until it is completely filled—care being taken that all clots, loose stumps, &c., have been previously cleared away. Should it be desired, any of the usual styptic or astringent applications may be employed along with such pressure. Of these, perhaps the most effectual is the saturated solution of perchloride of iron in glycerine. The lint may be soaked in this solution previously to its being employed as a plug; but there is little doubt that whatever accessories may be had recourse to, pressure, accurately and continuously applied, is here the most reliable measure for the suppression of hæmorrhage.

CHAPTER VII.

FILLING OR STOPPING TEETH—THE MATERIALS EMPLOYED, AND THEIR MODES OF USE.

FILLING or stopping a tooth affected by caries is an operation requiring care in many ways, and attended with considerable difficulty in its performance. A tooth selected for filling should not be too far advanced in decay. The intention of the operation properly is to save what remains of a tooth, rather than to restore it to its original bulk. What is desirable is to fill up the cavity left by an attack of caries, and so to cover up and protect the exposed but otherwise sound dentine into which such cavity has opened. If this cavity have extended completely through the dentine, so as to reach the sensitive pulp in the centre of the tooth, the operation becomes more complicated, and the chances of success greatly diminished. If the crown of the tooth be nearly all gone, and what remains be occasioning suffering, or where the

tooth is loose, or where the root or socket is inflamed, or where gum-boil has existed in connection with the tooth, stopping, as a general rule, should not be attempted. Exceptional cases do now and then occur, but teeth, in such conditions as those described, do not fall within the scope of this operation. Its legitimate object is strictly that of merely plugging up a cavity penetrating the dentine where the disease is limited to this lesion. And if patients allow the disease to proceed, or if it be overlooked in any way until total or almost total demolition of the crown of a tooth be accomplished, then extraction, and not stopping, is the proper remedy.

The first step in stopping or filling a tooth is to get ready access to the cavity, so as, if possible, to see into it. In order to do so, the patient must be placed in a position that will most accommodate the operator. If the cavity exists between the adjoining sides of front teeth, they had better be separated by stretching a small, flat strip of India-rubber, and inserting it between them, so that, on contracting by its own elasticity, it will either at once, or in some hours afterwards, separate the teeth. If the

cavity exist between the molar or bicuspid teeth, their adjacent sides should for a like purpose be cut away to a certain extent by an enamel-cutter or a file.

The second step is to clear out the cavity, and to shape it so that the stopping may be securely retained. A large amount of softened dentine will generally be found lining the cavity in a carious tooth; this must be cleared away by means of the small hoe-shaped instruments termed Excavators, until the sound, firm, normal dentine is reached. The enamel edges forming the mouth of the cavity should be reduced to a regular form, so that no rough, overhanging, or projecting portions may be left. And if not perfectly cylindrical, the cavity itself, so cleared out and prepared, ought to be as nearly so as possible, and, if anything, rather larger within than at the orifice.

In many cases, however, it would be disadvantageous, even if it were possible, to obtain a cavity of this kind. The decay is often shallow, although somewhat extensive superficially. In other cases, one part of it may be deep, while the rest diminishes in extent, and approaches the surface by a gradual incline; a form of

cavity frequently found on the sides of the upper front teeth, where it exists as a deep excavation at the neck of the tooth, and gradually diminishes as it comes to the surface and approaches the cutting edge, until it forms a mere chink or fissure in the enamel. In these cases, the edges of the cavity should be well counter-sunk, or what are termed retaining points may be cut, in order to fix the stopping in its place; these consist of little hollows or pits drilled in various directions into the dentine forming the walls and floor of the cavity, so that the stopping, being inserted into such pits, is more securely fixed than if it merely had the unbroken interior surface of the cavity to depend upon.

The third step is to fill the cavity. This must be done with some material which will withstand the effects of such decomposing influences as it may be subjected to in the mouth, and the usage to which it is liable in mastication. The most common substances employed are different preparations of Gutta percha, various Amalgams, and Gold or Tin foil. Several materials are also employed as temporary stoppings, where a tooth is so tender as to render it advisable to delay filling it permanently. These are such sub-

stances as cotton wool, dipped in a solution of mastic, or of gutta percha in chloroform, or a thick solution of either of these, formed into a paste with chalk, tannin, or such like, and which, by renewal from time to time, may serve to protect a carious cavity from the air until its sensitiveness becomes diminished.

Among permanent stoppings, the amalgams usually employed are those of various proportions of tin and silver, formed into a paste with mercury. Palladium, cadmium, and even gold, have been added to such amalgams, but the advantages thus derived, if any, have been very trifling, and for all ordinary purposes an amalgam of silver, tin, and mercury, will be found as good as any other, where this form of stopping is applicable. The tin and silver should be melted together, and run into an ingot; it can then be reduced to filings of sufficient fineness to mix easily with the mercury when required.

Where gold foil is used as a stopping, it should be quite pure, and so thick, that a leaf of it, about four inches square, should weigh from three to six or seven grains. Tin foil may be used a little thicker.

When the cavity is prepared, as already described, it should be filled up with some cotton wool, to prevent the entrance of foreign substances previous to introducing the stopping; and immediately before the process of filling is commenced, the cavity should be thoroughly dried, and kept as dry as possible during the process. If gutta percha stopping is the material employed, a pellet of sufficient size is to be heated over a small flame—not in hot water—until it is as soft as it will become without burning; and if the tooth can bear it, the plug should be inserted in this state, and packed into every crevice, care being taken that especially the orifice of the cavity should be hermetically sealed up by it. The instruments necessary for this process are few and simple, and they answer equally well for amalgam fillings. They are what are termed Pluggers, and consist of instruments about six inches long, having a steel shaft fixed in a handle of wood or ivory, and sometimes the shaft itself so formed as to dispense with this construction. The shaft terminates in a blunt rounded point, bent nearly at a right angle, about half an inch from the end of the instrument, so that the

extremity may be easily inserted into the cavities in molar teeth, &c. Three sizes of these instruments will be sufficient, of the respective diameters at the point of one, two, and three-sixteenths of an inch.

Where amalgam is used nearly the same proceedings are required as in the working of gutta percha fillings, with the exception that the amalgam is plastic at ordinary temperatures. The metal filings and the mercury should be rubbed up together in a small mortar, and afterwards kneaded in the palm of the hand by the finger and thumb, until all the superfluous mercury is squeezed out. The cavity should then be lined with the amalgam, more and more of which should be added until the stopping is complete. Neither in gutta percha nor amalgam stoppings should any superfluous quantity be left about the tooth, nor should any part of the stopping be allowed to press on the gum or adjoining parts.

Filling with gold or tin foil is a much more difficult process than either of those described. No mere description of the various modes of operating will ever enable any one to become expert at its performance without actual prac-

tice. The principles upon which this method of stopping is conducted are, that the first portions of foil introduced being accurately adjusted by pressure to the floor and walls of the cavity, and each successive portion, as it is added, being consolidated against the preceding ones, the whole being, if possible, so arranged that the edges and not the sides of the layers of foil shall appear on the surface of the plug, an all but solid mass of metal shall exist within the cavity on the operation being finished.

The instruments employed are in their general form somewhat like those for amalgam stopping, but instead of rounded or blunt-pointed extremities, the pluggers used for foil-stopping are chisel or wedge shaped, and sometimes serrated at the edge. Various sizes and curves of such instruments are required to enable them most easily to enter any cavity according to its situation. The foil to be introduced may be lightly rolled into little soft pellets, or into short cylinders, or a strip may be folded and twisted into the form of a loose rope, or, in short, fashioned in whatever form may be found to pack with most security and

solidity, according to the nature of the cavity and circumstances of the case.

Perhaps the best mode is that where all the foil introduced shall be in one continuous piece, such as in the method where the rope form is selected. One end of such rope is to be introduced and applied against one side of the cavity; and by doubling the rope upon itself, portion after portion of it is introduced in a zig-zag manner, until it is quite full. The remainder which may project beyond the cavity being forcibly compressed and burnished down to the level of the tooth's surface, the operation is completed. Whatever method be adopted, the cavity must in one way or other be packed quite full, the object in all cases of stopping being to produce a plug that shall completely fill the cavity, resist chemical action, withstand the tear and wear of mastication, and be impervious to fluids.

Where teeth are so sensitive that stopping cannot be performed, it sometimes becomes necessary to destroy the pulp entirely. This, in straight single-fanged teeth, may be done by boring it out, by inserting a slender, square-sided, pointed instrument, termed a broach, into

the fang, and rotating it once or twice. Where more than one fang exists, this cannot be done, and in these cases some escharotic, such as chloride of zinc, or even common white arsenic in very minute quantity, may be introduced into the cavity, and retained there by a temporary filling of wax or gutta percha for some hours, when it should be removed, and next day the stopping may be proceeded with.

Sometimes, after stopping with any metallic substance, heat or cold more readily produces uneasiness, owing to the better conducting powers of such metal. Here some other stopping may be tried, as, for example, gutta percha. But should such symptoms continue, extraction will most probably be required in the end. Occasionally, also, a stopped tooth may become the cause of insufferable pain, owing to some discharge of matter from its carious surface being pent up by the stopping. In such a case, the stopping may be removed or a hole drilled into the pulp beyond the cavity which has been stopped; but as this is almost reducing the tooth to its former condition, for which the stopping was performed, extraction is the more rational treatment.

CHAPTER VIII.

ON CHLOROFORM, AND OTHER ANÆSTHETICS IN DENTAL SURGERY.

CONSIDERABLE attention has been directed towards discovering or elucidating those methods by which pain, during the performance of the little operations required in dental surgery, might best be diminished or altogether avoided; many of the experiments, with such a view, have been conducted with much assiduity and not a little expense; and there is no doubt that some credit is due to those who have, even by the failure of their proposed methods, contributed to our knowledge on the matter. The means adopted have generally been of two kinds, namely, 1*st*, The induction of a state of general anæsthesia; and, 2*d*, The induction of insensibility at that part only where pain is to be inflicted.

Perhaps in no other operations have the circumstances of the case to be more taken into account in the induction of anæsthesia, whether

local or general, than in those performed within the cavity of the mouth. The locality itself, the severity of the pain inflicted, and, at the same time, its short duration in dental operations, and the complications attendant on the interference, here sometimes unavoidable, with the function of respiration or even deglutition—are circumstances which present themselves for consideration, as specially attaching to this department of surgery, and sometimes entailing extra risks to what are inherent to the employment of anæsthetic agents in other cases, where the operations are in a different and more accessible quarter; and it is mainly owing to these facts that so much difficulty and so much variety of opinion exists with reference to the employment of such obtunding agents in the practice of dental surgery.

For some time back it has been an object with dental practitioners, to discover, if possible, some mode by which *local* insensibility to pain during tooth extraction might be obtained; no generally applicable or effective means of this kind having as yet been realised, although the investigations and experiments made with this object have been numerous, and, in many instances, well conducted. For how long a time the idea has been entertained

that tooth extraction might be performed without pain, it is difficult precisely to determine; nor is it easier to enumerate all the different modes which have been adopted with such an intention in view; but we know that for similar operations *local anæsthesia* was mentioned by the ancients, as by Dioscorides, and described as a possible if not an ordinary mode of practice among surgeons and others; and it has long been popularly asserted, too, that the Chinese have for some unknown period been, and are now, the possessors of a secret method of extracting teeth without pain or suffering of any kind. Various statements exist in reference to what their method consists in; it has been described as a process by which insensibility of the part results from the application to it of some substance of a benumbing or powerfully anodyne nature—but what this substance is, if it exist, appears to be involved in mystery. On the Continent, too, and sometimes in England, every one is aware of the manner in which the well-known mountebank practitioner puffs his wares, and sets off the painless nature of his operations—especially tooth-drawing; and how implicitly his "Clientelle" seem to embrace his confident assertions,

rather than give way even to the testimony of their own sensations.

1*st*, Regarding the local application of Anæsthetic Substances, more properly so called. Little need be said of the attempts to induce local insensibility by mere external application of these agents, since, as yet, it has failed to produce effects anything like sufficient to enable a tooth to be extracted without pain. Chloroform, ether, opium, aconite, amylene, bi-sulphuret of carbon, cyanide of potassium, hydrocyanic acid, &c., have all been tried in this way, and the result has been to prove them, when merely applied to the unbroken surface, as entirely ineffectual for such purposes.

2*d*, Congelation of the parts by the application of freezing mixtures has been suggested for the induction of local insensibility during tooth-extraction, and other operations in dental surgery. This mode of inducing local anæsthesia, although by no means new, was some time back revived by Dr Arnot of London and others, and some ingenious enough contrivances were brought forward with the view of facilitating the employment of this agency, and rendering it serviceable in dental operations ; as yet its application, how-

ever, has been by no means easily managed, nor at all certain in its effects, even if it could be said to be without danger in those cases where insensibility might happen to be produced. There is no doubt that where a part is frozen hard, insensibility is lost. But to produce this effect satisfactorily, is much easier in theory than when it comes to be put into practice. Within the cavity of the mouth, as has been already observed, several difficulties have here to be contended with: 1*st*, There is the difficulty of effectually applying cold at all in this manner, except in some easily accessible quarter of that cavity; 2*d*, There is the uncertainty of pain being avoided after all, no matter what apparatus be used—as, even supposing the part has been fully frozen, the slightest delay or accident during the operation entirely frustrates our object here; and, 3*d*, There is no doubt that unpleasant results may at any time be the consequence of such an injury being inflicted on a part which is frozen, as that entailed in the extraction of a tooth. The pain produced by the freezing process itself, too, is in many cases worse than that of extraction.

3*d*, Another method attempted for the pro-

duction of local anæsthesia has been the application of Galvanism or Electricity. Partly, it would appear, owing to some misconception of the results observed in certain physiological experiments made on the nervous system of these agents, and partly, it may be, owing to an erroneous notion entertained in reference to the feeling experienced in a part through which the electric current is passed, the conclusion seems to have been come to by some dentists, that electricity could be easily employed as a local anæsthetic. But the mistake here committed seems to have arisen from confounding mere *altered* with *arrested* nervous sensation, as the pain of the operation, in fact, becomes under this agent not less in amount, but different in kind—the electric thrill not supplanting, but being superadded, to such pain.

There seems, however, to be no reason for altogether despairing of ever being able to discover some mode of producing insensibility over a limited surface. We know that several anodyne remedies produce this effect *to a certain extent;* and from the relations of the teeth to the tissues covering them—no part of them being in reality at any depth from the surface—we may, at least,

hope with some confidence in their extraction being yet practicable with much amelioration, if not entire absence, of pain. In the meantime, however, no method which has been tried can ever be compared, either for facility or effectiveness, with that of inducing a state of *general* anæsthesia; and to do this, chloroform, so far as our knowledge of such agents as yet extends, is decidedly the most desirable in every way. The late Dr Snow of London gives an interesting *resumé*, in his work on Anæsthetics, of the history of these agents. About the close of last century, Sir Humphry Davy instituted a number of experiments with Nitrous oxide gas, as an anæsthetic; and this eminent philosopher suggested that this gas might yet "probably be used with advantage during surgical operations." The honour of first acting on this suggestion seems due to the department of dental surgery. This occurred so long ago as December 11, 1844. The operator on this memorable occasion was Dr Riggs, the patient, Mr Horace Wells, both dentists of Hartford, Connecticut. The story is well known. Nitrous oxide was found to be uncertain in its results; a case having occurred where it failed to prevent

pain in tooth extraction, and that in presence too, be it remarked, of Drs Charles T. Jackson, professor of chemistry, and W. T. G. Morton, surgeon-dentist of Boston. Now, besides nitrous oxide, Sulphuric ether had been at that time for more than twenty years known to resemble in its effects those of nitrous oxide; and knowing this, and nitrous oxide having failed, Dr Morton, on the 30th September 1846, exhibited sulphuric ether to a patient, and extracted a tooth without pain. A question now arose between Jackson and Morton (although both were associated in a patent regarding the application of ether), as to which of them had been the means of bringing its properties to light; and, in the meantime, Dr Bigelow of Boston communicated the matter of its exhibition by them in such cases to Dr Boot of London. The result was that Mr Robinson of Gower Street, administered ether and extracted a tooth painlessly to a young lady, at the house of Dr Boot, on the 19th of December 1846. On the 19th of January 1847, Professor Simpson administered it at Edinburgh in a case of labour, and ascertained that it was capable of removing the sufferings of the patient without interfering with the process of parturition. Ether

was now becoming more and more widely and confidently used in general practice, when Professor Simpson, having had his attention turned to such matters, discovered that another substance, Chloroform, possessed such advantages over ether, that he at once laid it aside, and adopted and recommended the employment of chloroform in its undiluted state, as incomparably superior in every respect. The new anæsthetic was tested, and found so suitable, that to the present day it stands unrivalled.

According to some elaborate investigations made on this subject, five different degrees of narcotism seem to be producible by chloroform. The first of these includes all the effects of that agent so long as perfect consciousness remains; the second is while the mental functions are impaired, but not necessarily suspended; the third is when voluntary motions cease—this also being the stage in which rigidity of the muscles and inarticulate mutterings occur, and the *perception* or *consciousness* of pain is lost; the fourth degree is during the complete relaxation of the muscles, when the breathing is stertorous, and the patient perfectly insensible; the fifth degree is that

where embarrassment or cessation of the breathing takes place; and the ultimate and greatest effect chloroform can produce, is described as that where the irritability of the muscles is destroyed, and *post-mortem* rigidity induced. These seem certainly very clear and distinct divisions of the consecutive phenomena of anæsthesia produced by chloroform. So much, however, in actual practice does each blend with and lose itself in another, that it is very rarely such stages can be made out with so much precision that they should be of much use or serve as anything like beacons by which to steer clear of danger; and as for any certain indications of having attained the sole object we desire in administering anæsthetics at all—insensibility to pain—we can confidently depend on having done so only when patients exhibit, among other symptoms, those here constituting the fourth degree of narcotism.

It would be out of place here to enter upon the views entertained and promulgated regarding death from chloroform. It is a great deal to know that death can be produced by it, and that there is no doubt of death having been so in a small number of instances. It cannot be

said that in every case the system has been *poisoned* by the chloroform, but the patients have died; and whether their death was directly or indirectly due to it matters little, if it was due at all. The practical lesson taught is to keep a sharp look-out in every direction, to be alive to every kind of danger, and to be prepared to act at once in every emergency, as here, above all other occasions, delay or indecision is fatal. And too strong terms cannot be employed to reprobate the exhibition of such agents as chloroform by persons whose qualifications are insufficient for meeting any collateral emergency. Supposing any unfavourable symptoms to arise, what happens? Probably some qualified practitioner, who has in the meantime been sent for, arrives, but only to find the patient dead; and the death is concluded to have occurred notwithstanding every endeavour having been employed. The qualified practitioner may no doubt have been at once called in; but it is like calling in a medical man to drag for a drowned person—medical skill is then of no avail.

The first and the principal object in exhibiting chloroform, then,—for we may here consider

it as the type of all other anæsthetics,—is the avoidance of pain; but there are two subordinate objects in its exhibition which are nevertheless of much importance, and most desirable; these are the avoidance of shock to the system, and the means of rendering the patient completely passive in the hands of the surgeon. None of these ends, however, will be accomplished, if the state of anæsthesia be not complete; and to produce this complete anæsthesia, and to know when it is produced, requires not only an intimate knowledge of the properties of the anæsthetic agent itself, but a certain amount of tact in its exhibition, to be acquired in no other way than by practical experience in its use.

In what cases, it may be asked, is chloroform to be refused? So far as my own experience goes, it can only be stated that no such case has been met with. In some instances, no doubt, there are physical obstacles to its inhalation,—such as the cough excited in some cases of bronchial irritation, the early accession of vomiting, even the existence of nasal polypus, and other complications connected with the act of respiration; but these are mere impediments to its

administration, not contra-indications to its use, and they form, besides, so small a proportion of cases as to be almost inappreciable. So far as age is concerned, no special contra-indications to its employment exist under this head. So far, again, as disease is concerned, it is impossible to prognosce its applicability or its non-applicability, as in the most unlikely cases its effects are often all that could be desired, while in cases where everything promises well, its employment is sometimes found to be less satisfactory, and requiring more care. In short, the propriety of its employment is to be judged of by, and consentaneously with, the effects produced; not by any prejudgment of what its results are likely to be. And so few are those instances where its use is positively precluded, that its employment may be here considered as of universal application.

Always bearing in mind that the part to be operated on should be placed so that the surgeon shall have the greatest possible facility for examination and manipulation, the most convenient and safest attitude for the patient during the administration of chloroform is the recumbent or horizontal position. The dress about

the throat and chest should be loose; the neck should in all cases be without any covering whatever; and the clothes upon the chest should be so arranged that all the movements of respiration may be at once and easily observed. In operations within the mouth, it was, and to a less extent it still continues, customary to introduce a cork or some such substance between the teeth previous to or during the exhibition of the anæsthetic. Such a practice is far worse than useless. The very first inhalations of chloroform in many patients create a slight degree of irritation in the fauces, often increase the flow of saliva, and generally excite a desire to swallow. This cannot be accomplished so long as anything keeps the jaws apart; the patient consequently struggles to rid himself of the difficulty; his struggles are mistaken for mere cerebral excitement; a contest takes place between the half-insensible patient and his attendants; and probably the attempt to produce a state of anæsthesia is in the end abandoned. All such proceedings occasion delay. In exhibiting chloroform for such operations as those of dental surgery, it will be well to have everything so arranged that the patient may be

kept under its influence for as short a time as may be compatible with the requirements of the case. The sooner the anæsthesia is here produced after commencing to exhibit chloroform, and the sooner the patient can be relieved from its effects when they are no longer desirable, so much the better. The operation itself ought to be completed with all possible celerity, and nothing like hesitation as to the particular instruments to employ, or loss of time selecting those required, or in any mere examination of the parts, should at this stage interfere with the proceedings. All these matters should be anticipated. The instruments likely to be used should be laid out in order before commencing to exhibit the chloroform; and, if possible, kept out of the patient's sight. The tooth or teeth to be extracted should, at the same time, be thoroughly examined, and the expedience of adopting one or other mode of extraction be then decided on. In order that speedy insensibility may ensue, perfect silence should be observed. The patient ought, if possible, to be without any apprehension that the anæsthetic is hazardous, or that no effect can be produced by it, or that the operation will be commenced before a

sufficient quantity has been inhaled. Wherever a patient is nervous or anxious about these or other similar matters, it will be found that a much larger quantity of chloroform will be required than would otherwise be the case. Another point of some importance is the frame of mind in which a patient comes under the influence of this anæsthetic. If an effort be made to go quietly to sleep, there is little chance of much struggling or involuntary restlessness. On the other hand, where a patient, especially in the case of all minor operations, entertains the belief that, under the influence of chloroform, the conduct is necessarily outrageous, it seldom fails that such an idea is practically realised. Indeed, in not a few instances it would almost appear as if the patient had premeditated the display sometimes made during the exhibition of such agents ; and in all cases it is advisable that the patient should be instructed to remain as quiet as possible, so long as sensibility is retained. In this way, with a little effort on the patient's part, the whole operation may be rendered much more satisfactory both to himself and the surgeon.

The mode of exhibiting the anæsthetic agent

has been a subject of considerable discussion, and this is a point of some importance in Dental Surgery. Various forms of inhalers have from time to time been brought forward, each being by its own advocates described as superior to all the others, and all of them as preferable to exhibiting the anæsthetics in a napkin or handkerchief. It must be kept in mind, however, that the less we have to attend to besides the patient, the less risk there is of danger; whereas, if attention has to be bestowed on the working of an apparatus, complicated as these inhalers occasionally are, it necessarily interferes with that close watching of the patient which is in all cases absolutely essential. Much importance has been attached to the waste of chloroform resulting from the use of a napkin. A very little consideration, however, will show this to be a waste of the most trifling nature, comparatively of no moment whatever, never in any case amounting to more than the value of a sixpence, or at most a shilling, and seldom to any appreciable amount at all. Again, it has been argued that the patient gets too much chloroform by using a napkin. To this it may briefly be replied, that this is the fault of those administering it. If the chloro-

form be properly managed, and be withdrawn on insensibility being complete, it is no great matter in this respect what has been used for conveying this agent, as in all probability precisely the same quantity will in any way be *inhaled* to produce a like effect in the same time, unless, indeed, a repetition of very small quantities be administered, when a great deal more will be inhaled with a much less satisfactory result; and that only after subjecting the patient to an uncalled-for and inexpedient protraction of every stage of anæsthesia. Another circumstance rendering any extra complication in the inhaler objectionable, is the frequency with which the inhalation sometimes requires to be suspended and renewed. This especially applies to operations on the mouth and in its neighbourhood, as, for instance, in the extraction of a number of teeth at a time, where the patient becomes conscious during the operation, and requires an additional dose of the anæsthetic to be administered, while perhaps the position of the head and the condition of the mouth would render any special apparatus difficult to adjust, not to speak of the flow of blood rendering them dangerous.

The safest and the easiest position for the

patient is, as has been already said, that of reclining on a couch or sofa, so that the operator may have free access to the parts requiring operation. For this purpose, a low couch, raised at one end, and without a back, will be found very serviceable—the patient being laid in a semi-recumbent posture, with the head supported on the raised end of the couch. The chloroform should be given in large quantities—not less than a dessert-spoonful being poured on the napkin at a time, and this quantity renewed as soon as the former supply has passed off. The handkerchief should be held at the first about two inches from the patient's face, enjoining him to close the eyes, so as to avoid the smarting otherwise apt to be occasioned. As the anæsthetic effects begin to appear, the napkin may be brought into closer proximity with the face, until at last it may be applied in actual contact with the mouth and nose, and kept there, unless there be any contrary indication, until anæsthesia is complete.

The quantity of chloroform inhaled before perfect anæsthesia is induced, varies very much in different patients; and there is also a great difference in the rapidity with which one pa-

tient, in comparison with another, will inhale a given amount of chloroform. Owing to these two circumstances, the time required to produce complete insensibility ranges among various patients from a period of a few seconds' duration upwards, to cases where the inhalation requires to be kept up for five or ten minutes, or more, before a sufficient effect is obtained; and, judging from personal observation, it is in the latter class of cases that vomiting and after-sickness most frequently occur.

Something might here be said regarding the quality of the chloroform itself; but, excepting that it should possess the normal strength, little difference seems to be made in this way, unless great impurities exist. For example, methylated chloroform has now been extensively used without any evil result. Nay, more, some instances have occurred where sickness and vomiting could only be avoided after chloroform, by using that manufactured from methylated spirit. On the whole, then, and with a fair quality of chloroform, the simplest, and, I should certainly say, the safest mode of exhibition, is on a napkin, folded several times, so as to prevent the too sudden evaporation of the anæsthetic. It has

been proposed to exhibit this agent, by placing only a single layer, or a thin stratum of such napkin, over the mouth and nose, and dropping the chloroform on it continuously, as it becomes evaporated. One difficulty, however, attaches to this method, in the sudden and frequently-repeated turning of the face from one side to another, so often met with during the inhalation of chloroform for dental operations, as if in apprehension that they were to be commenced, and which displaces the napkin so much, that in such cases this mode of administration becomes impossible. The method, then, attended with fewest drawbacks, and the one by far the most convenient both for patient and practitioner, is that of the folded napkin, well charged with chloroform, and applied over the mouth and nose, as described above.

Simple as such a proceeding, however, may appear, it is one where many points of vital importance demand the greatest care and attention —and most undoubtedly, considering the emergencies which may possibly arise, and the procedure necessary on their occurrence, during the administration of any agent of such powers—its use, as has been already said, in any hands

except those qualified to meet whatever accidents may take place, or to treat at once and on the spot the first manifestation of untoward symptoms, is on each occasion neither more nor less than tampering with and hazarding a human life.

I have stated that, previous to or during the exhibition of chloroform, no substance should be placed between the teeth, so as to keep the jaws apart. But, after the anæsthesia is complete, it will, in general, be found necessary to separate the jaws widely, and to retain them so, in order that the operator may command a ready access to, and have a full view of, the parts. When the anæsthetic condition is sufficiently deep for performing painlessly such an operation as the extraction of a tooth, little difficulty will commonly be experienced in merely opening the mouth; since, from the muscular relaxation induced, the lower jaw will droop, by simply allowing the head of the patient to fall back to a slight extent. Exceptional cases do now and again occur, however, where the teeth, and even the lips, are closely and forcibly kept shut. But in no case is the difficulty so great as not to be easily overcome, by simply inserting between

the front teeth the end of any thin flat body, such as the handle of a tooth-brush, and rotating it, so that the teeth, or, where these are absent, the gums, shall then be separated by, and rest upon, its edges. This being once accomplished, any suitable gag may be placed between the molar teeth of the side opposite that to be operated on; and by moving it backwards or forwards, the same size of gag may thus be made to open the mouth to various different degrees. In 1854 I published, in the "Monthly Journal of Medical Science" for April of that year, an account of a speculum for purposes of this nature, and which, in certain cases, is found useful, as it remains more steadily in position than those generally employed, and dispenses with the necessity of being held by an assistant—a proceeding sometimes interfering with the required amount of light and space. The instrument is tolerably well known; and for further particulars I must refer to the above publication. On the whole, however, as with the use of inhalers, &c., the simpler all such auxiliaries are the better; and, with a little judicious management, nothing beyond the measures above described will be found necessary,

in ninety-nine cases out of a hundred, for opening the mouth, and retaining it so to any extent desirable.

While administering the chloroform, then, the patient should be left the perfectly unconstrained power of deglutition, and it should be inhaled, in an easy and placid manner, through the nostrils. Any forced or rapid inspirations do little good, and sometimes give rise to difficulties, as they are almost always followed by a cessation for a time of the respiratory act altogether. This symptom, above everything else, is to be avoided; and on anything like an interruption to the regularity of the breathing being observed, the chloroform should be at once withdrawn. If it appear that any obstacle to the entrance of air exist at the back of the mouth or pharynx, so that the opening of the larynx might be closed, this, it need not be said, is to be immediately removed. During the state of complete unconsciousness, and especially when the patient is lying horizontally on the back, the tongue is apt to fall, or to be retracted towards the gullet; and in this way a danger of suffocation has been apprehended. The practice of some of our highest surgical

authorities is on these occasions to draw forward the tongue with forceps—generally artery forceps—or by means of a tenaculum, and sometimes, where the organ seems likely to require being kept forward for a time continuously, a ligature is passed through it, and held by an assistant. In certain cases these proceedings may be demanded, particularly in such as those of performing excisions about the jaws, &c. But it must be kept in mind, that the accumulation at the orifice of the larynx of a quantity of saliva or bloody fluid will choke a patient almost as readily as if the larynx were closed up by the tongue or epiglottis lying there. Now, to rid himself of an obstacle to the respiration such as saliva or blood, the patient always endeavours to swallow; but, where the tongue is kept forcibly extended this is impossible, while the lodgement of fluids on, and their passage into, the larynx is here rendered more likely to occur by its exposure. Except in special cases, then, so long as the respiration is seen to go on, nothing need be done in this way at all; and when there appears to be any tendency to disturbed, or obstructed, or arrested breathing, the chloroform should be at once withdrawn, and merely the

fore-finger thrust well back into the pharynx, where, by a few simple movements, the fluid can be removed, deglutition, in all probability, be at once excited, and the tongue pulled forward if necessary. I may be here permitted to remark, that in the record of at least a thousand consecutive cases of complete anæsthesia, I have never had occasion to resort to any other measures than those last mentioned.

It is seldom before, and generally after, the accession of insensibility, that sickness with vomiting commences; and it is only when it commences before or at this stage that it forms anything like a serious impediment to the surgical procedure, as, after this is effected, its occurrence is of but little consequence. When vomiting begins about the time of the operation being commenced, the anæsthesia is generally so well established, that, on the first paroxysm of sickness passing off, a very little more chloroform will restore the anæsthetic state so speedily, that, before the re-accession of vomiting, the operation may, in the majority of cases, be successfully completed. When it begins earlier than this, however, the difficulties are increased, and in some cases render it injudicious or im-

possible to continue administering the chloroform. It is superfluous to say, that of all operations those on the mouth and in its vicinity are such as are most interfered with by vomiting. In this way, it becomes a complication of a most troublesome nature to the surgeon. But it by no means rests here; for it also entails most serious risk to the patient, inasmuch as in many cases there results from this cause very great danger of suffocation. The vomiting, when anæsthesia is deep, often seems to be defective —the contents of the stomach gurgling up into the mouth, in small quantities at first, and with apparently an inability to eject the vomited matters any further. In this way these are sometimes accumulated at the upper part of the gullet and pharynx, and, unless due caution be exercised, the larynx may thus be shut up, and respiration prevented. The ordinary rule is not to exhibit chloroform until the expiry of four hours or thereabouts after the last meal, so that the stomach may be empty—a condition in which it is supposed that sickness is less likely to occur. Patients, however, sometimes deceive the operator in this respect; and in other cases digestion seems to proceed at a very slow rate

previous to the expected operation. In children, more particularly, every one who has administered chloroform in any number of cases, will recollect not a few instances of vomiting marked by the re-appearance of eatables almost as fresh, and with as distinct evidences of their nature and composition, as when they were swallowed. In this and other ways, then, with a patient unconscious and utterly helpless, an operation half completed within the mouth, and a stomach charged with half-digested food, vomiting may be conceived to be an occurrence by no means void of danger.

Subsequent to the operation, sickness is sometimes found to persist for several hours. This is a symptom of a distressing and exhausting nature, with which it is difficult to deal. Time alone appears to be the true remedy in such cases; but a temporary remission of the feeling of nausea may be derived in some instances by the use of alcoholic stimulants or opiates; in others of ice; in others again of strong coffee, effervescing draughts, &c. &c. In all cases, however, rest in the horizontal position, and the avoidance of food, especially fluid matters, for an hour or two, should be enjoined; and these

measures alone will generally lead to the feeling of sickness passing quietly away, as the chloroform becomes eliminated from the system. It is not improbable, that in certain cases the method of rousing the patient from the state of unconsciousness may have something to do with the accession of after sickness. No violent measures should ever be resorted to for such a purpose; no shaking of the patient; no loud speaking or vociferating into his ears; no attempt of any kind to awake him the moment the operation is over; and certainly no allusion of any kind should be made to sickness or vomiting. The patient ought to be allowed to lie perfectly at rest—to have free access of air, and not be permitted to speak or be spoken to, so long as any mental confusion exists.

In concluding these remarks, it may be observed, that, so far as concerns the appreciable stages of anæsthesia manifested in any individual instance, the practical experience of one or two cases would be more instructive than any amount of description. Suppose one of the average class of patients about to be operated on, and that the inhalation of chloroform has been commenced. In general, an ill-disguised apprehension; an

indefinable anxiety betraying itself in repeated and trivial interrogations and injunctions; a watchful cognisance of all going on, present themselves as familiar features of what may be termed the preliminary stage. The passing away of agitation; an interval of tranquil breathing; the accession of forgetfulness, interrupted now and then by a sudden return to consciousness; a wavering confusion, with occasionally a recurrence of the interrogative and admonitory anxiety of the first stage, characterise the earliest onset of anæsthesia. Again, the breathing becomes tranquil; occasionally, as if a hazy perception of passing events existed for a moment, the eyelids are raised, apparently in warning that insensibility is not yet complete; and now, with their reclosure, the last gleam of mental power is darkened, and all is purposeless, involuntary, unbalanced, unheeded. A few more inspirations, and the drowsy snore, the relaxed muscles, and the countenance expressive of utter unconsciousness, proclaim the full power of the anæsthetic to have been attained. Whatever pain be now inflicted, it is no longer felt. No resistance, no terrors interfere with the proceedings of the surgeon; and at their close, the dawn

of returning intelligence brings no recollection of what has occurred. A dreamy sense that, for a time, oblivion has prevailed to all around; and, with the awakening intellect, the realisation that suffering has been supplanted by a sleep, usher the patient once more, as it were, into existence, and anæsthesia has fulfilled its purpose.

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